JPRS 76135

30 July 1980

USSR Report

ENERGY

No. 23

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FUELS

ELECTRIC POWER

HISTORY, CURRENT STATE OF WORK ON AES FAST REACTORS REVIEWED

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 2, 1980 pp 74-79

[Article by Oleg Kazachkovskiy, director of the Physico-Energetics Institute of the State Committee for Atomic Energy of the USSR: "Condition and Outlook for Work to Create AES with Fast Neutron Reactors"]

> [Text] Our duty is to think about the power engineering of the future in advance; the economic growth of the country depends on it a lot. Consequently, in the long-term plans the extensive construction of nuclear power plants with fast neutron reactors must be envisaged.
>
> L. I. Brezhnev

The start-up of the first nuclear power plant in the Soviet Union in Obninsk in 1954 marked the beginning of an era of the peaceful use of nuclear power. The country of the Soviets, demonstrating its fidelity to the principles of humanism, has directed the powerful potential forces of nature for the good of man. The AES in Obninsk was a triumph of the advanced Soviet science and technology. It confirmed with new strength the indisputable advantages and the richest creative potentialities of the socialist society.

In the past years, nuclear energy has advanced far. In many countries of the world large AES are successfully operating, that in their economic indicators are not inferior to the standard power plants. They possess good operational qualities, are highly reliable and efficient. In spite of the sometimes extant prejudices, nuclear power is a safe branch of the national economy. Thanks to the colossal calorific value of nuclear fuel, the nuclear power plants are practically not linked to raw material fuel bases and can be placed in any regions.

Does this mean that all the problems associated with the development of nuclear power have been solved, and there are not longer any "blank spaces" here? Of course not! The fact is that the long-term growth of the branch

requires an every increasing quantity of nuclear fuel, natural uranium. In this respect, the question of their efficient use becomes acute. Nuclear reactors operating on thermal neutrons (thermal reactors) have been installed in almost all the extant and currently manufactured AES. With all of their positive technical and economic indicators, they suffer from one important shortcoming: only a very small part (only 1.0-1.5%) of the extracted uranium can be used.

The situation can be radically changed by using reactors that operate on fast neutrons (fast reactors). With a positive neutron balance they produce a secondary fuel that is formed of uranium, that in the main pattern is plutonium, in a considerably larger quantity than is burned during this time.

The expanded production of nuclear fuel makes it possible to convert into plutonium and burn up practically all the extracted uranium, including that which is sent to the dump.

In a technical respect, these units are more complicated than the thermal reactors. Therefore, their development requires considerably more efforts and time.

Systematic studies on the main questions of developing fast reactors began in the Soviet Union in 1950. The scientific leadership was provided by A. I. Leypunskiy, the eminent scientist and physicist, and companion of I. V. Kurchatov. It should be noted that this work was started several years before the start-up of the first AES, when the possibility of the industrial use of nuclear power in general was not yet experimentally confirmed.

Such an approach is characteristic in principle for the experienced period of the scientific and technical revolution, since the problems to be solved, as a rule, are vast and complex. If one waits until the end of one stage before passing to the next, then the rates of progress will be too low.

Of course, in order to make a decision on the further work, without having all the necessary initial data, it is necessary to possess developed scientific and technical intuition, and confidence in the correctness of the selected path. The collective that took up the matter possessed such qualities completely. The leadership and party organs gave a lot of attention and support to these comrades. And this produced results, and defined the high rates and quality of work.

In the beginning, efforts were directed mainly towards research on the physics of fast reactors, on the measurements of parameters for interaction of fast neutrons with matter. The main task of that period consisted of experimental confirmation of the ideas on the possible expanded breeding of nuclear fuel in fast reactors. It was mainly solved by the end of the 1950's. The answer was positive. After this, although the reactor-physical

and nuclear-physical studies continued, the center of gravity of the work gradually began to shift towards the engineering and technical area.

Back in the beginning period, preliminary drafts were made of variants of fast reactors with different heat-carriers: sodium, alloys of sodium and potassium, and lead with bismuth, as well as helium. Water proved to be unsuitable in its neutron-decelerated properties, due to which the breeding intensity was reduced. As a result of the work, it was found that liquid sodium is the most applicable heat-carrier. It possesses good thermal and physical properties that guarantee the fairly intensive removal of heat from the reactor that is necessary for technical and economic considerations. Its nuclear and physical qualities make it possible to preserve high breeding of the nuclear fuel with the required fairly large content of heat carrier in the active zone of the reactor. Sodium is completely technologically efficient at high temperatures that guarantee the attainment of good thermal efficiency. It is also important that it does not require high pressures in the reactor and does not create corrosion problems. Its good thermophysical properties promote organization of reliable emergency cooling down of the reactor. Sodium retains well the fission fragments that enter it during accidental depressurization of the fuel elements, which promotes localization of radioactivity in emergency situations. Therefore practically a clear selection was made precisely on it in those years.

We recall that we started the engineering and technical work, without essentially haveing any, not only industrial, but also laboratory, experience in using sodium as a heat carrier. Its development required a vast complex of scientific and technical studies and developments. Numerous test stands with sodium were made, the necessary technological methods of working with it were worked out, as well as the instruments for controlling its parameters, and methods of maintaining the necessary condition (for content of admixture) were formulated. All of this made it possible to arrive (and moreover, fairly rapidly) at the creation of experimental sodium fast reactors.

The first of them with sodium BR-5 (heat output of 5 Mw) was started up in the Physico-Energetics Institute (FEI) in Obninsk in 1958. The reactor provided unique experience on the technology of radioactive sodium heat carrier (with temperature up to 500°C). With its help important experiments were carried out on the physics of reactors, and valuable results were obtained on studying the effect of fast neutrons on the design and fuel materials. Here for the first time mass tests were made on fuel elements with plutonium dioxide.

In order to further expand the potentialities of testing the fuel elements under intensive conditions corresponding to industrial reactors, as well as tests of the equipment components at high temperatures of sodium (all the way to 560°C) in the Scientific Research Institute of Nuclear Reactors [NIIAR] in Dimitrovgrad of the Ul'yanovskaya oblast an experimental power

reactor BOR-60 (thermal output of 60 Mw) was constructed and in 1969 was put into operation. The presence of a small turbine made it possible to conduct complex studies on it of different stationary and transitional energy patterns. This reactor is distinguished by high density of the heat release that in individual cases reached 1200 kw per liter of the active zone. Thus an indicator is more than sufficient to ensure the economic efficiency of fast reactors.

The BR-5 and BOR-60 reactors made it possible to irradiate with fast neutrons with great fluents a considerable number of samples of promising reactor materials, and promoted the fulfillment of extensive materials technology studies that are an important component part of the entire program of developments of fast reactors.

In 1973, in Shevchenko of the Kazakh SSR the first industrial (demonstration) fast reactor BN-350 was put into operation. Its main parameters are given in the table. The reactor plays an important role in providing electricity and fresh water to the entire Mangyshlak economic region. At the same time, the studies made on it, in the same way as the general results of its operation, have great importance for the entire program of tests on fast reactors.

The most important result of these tests is confirmation of the good technological efficiency and safety of using the sodium heat carrier on a large industrial scale ($\sim$900 T of sodium). The fact is that in the beginning certain dangers existed that were linked to the high chemical activity of sodium during interaction with oxygen in the air, and especially with water. In principle, one could expect undesirable consequences if certain emergency situations developed. Therefore, from the very beginning especial attention was given to measures of increasing the safety and reliability of the operation of all the sodium systems. These measures include:

guarantee of a fairly high quality of installation and control of the equipment that comes in contact with the sodium;

installation at the necessary places of different types of insurance housings and other protective attachments;

use of specially developed instruments and systems for early detection and localization of malfunctions (leakages).

These measures were first worked out, verified on small-scale units, laboratory test stands and experimental reactors. The results were good. As shown by the experimental BN-350, the scale factor almost did not bring any surprises. Essentially, the sufficiency of the formulated requirements and the planned measures was shown. Practically all the main units--sodium pumps, mechanisms for the control system, mechanisms for overloading the reactor, system of control and measuring instruments--demonstrated high

performance capacity. Only one assembly, and only in the first periods, was the source of concern. This is the steam generator, i.e., the heat-exchanger, in which a heat drop occurs (through the walls of the pipes) from sodium to water--steam. There were several cases of malfunction of its individual sections (due to leakages of the pipes) when water entered the sodium (all the way to several hundreds of liters). Although this did not have any catastrophic consequences and no one suffered, such type of accident, of course, could be fairly unpleasant. As practice has shown, repair of the sections that have malfunctioned is very labor intensive and required a corresponding reduction in the output of the AES during the restoration work.

Since the beginning of 1976, the BN-350 operator has been operating stably with a very high coefficient of readiness--on the order of 90%.

Main Characteristics of Fast Power Reactors

Parameters	Measurement unit	BN-350	BN-600	BN-1600
Electrical output	Mw	150[1]	600	1600
Thermal output	Mw	1000	1470	4000
Gross efficiency	%		41	40
Maximum density of heat release	kw/1 ac.z.	730	840	710
Sodium temperature at outlet from reactor	°C	500	550	530-550
Steam: pressure, temperature	abs. atm.	50	140	140
	°C	435	505	490-510

In order to prevent such situations in the future, extensive work was done in the direction:

of improving the technology of production, control of steam generator quality in order to significantly reduce the probability of missing defects;

of perfection of the design of steam generators in order to increase their degree of immunity in relation to missed defects, as well as the possible deviation of the operating conditions from the rated.

Today the paths for creating especially reliable steam generators are already clearly seen; their designs practically exclude major accidents (use of small modules, employment of "inverse" designs, in which sodium flows in the pipes in contrast to those currently adopted, and water flows between the pipes, use of two-layer pipes, etc.). In 1980 at the Beloyarskiy AES in the Sverdlovskaya oblast a more powerful industrial reactor, BN-600 will be put into operation. It has higher technical parameters than the BN-350 (see the table), and uses somewhat different principles of equipment arrangement. At the same time, it employs many technical solutions that were

[1]Plus 5,000 T of freshwater per hour.

formulated and tested on the BN-350 reactor. The BN-600 reactor in its economic parameters is close to the extant AES with thermal reactors. With regard for the possibility of its further updating and perfection, it can be recommended for reproduction for a time, while a series fast reactor of even greater output, the BN-1600 (see table) is being developed.

The power reactor BN-1600, as can be expected, will possess high economic indicators that are not inferior to the corresponding indicators of the AES with thermal reactors. Now it is difficult to make strict calculations. For this it is necessary to possess the experience of creating and operating similar systems.

Nevertheless, in the amount of capital outlays, the fast reactors, due to their relatively great technical complexity are still inferior to the thermal reactors. With equal output of the units the advantage in the total balance of economic effectiveness is currently in the thermal reactors. At the same time, the absence of a vessel at high pressures, and great compactness make it possible, already at the given technological level of production to create fast reactors of greater unit output than the thermal vessel-type, which will reduce the specific capital investments. And this means, the general economic situation will alter more and more in favor of the fast reactors.

At the same time that questions are being solved of the near future that are associated with the practical development of fast reactors, long-term tasks are also being worked out. The main direction here, as before, is the use of a sodium heat carrier. We have in mind the study of potentialities and the expediency of the further increase in the unit output of the block, as well as the conducting of various types of research directed towards improving the reliability, simplifying the system, etc. A lot remains to be done also in the study of the possible use of fast reactors to generate industrial heat.

At the same time, a lot of attention is focused on alternative aspects of using gas heat carriers in the fast reactors--helium and dissociating gas (nitric tetroxide). The interest in gas heat carriers is linked to the outlook of a certain increase in the working temperatures, as well as simplification of the technological plan. In the maximum case of using dissociating gas one can speak of a one-loop plan.

In solving these and other basic problems, of ever increasing importance is the cooperation between the corresponding scientific research institutes and organizations of the CEMA member countries. This cooperation began already in the middle 1960's. At precisely that time the first joint work was done by the specialists of the GDR, USSR and CSSR on the problem of fast reactors. In 1972, upon the decision of the permanent commission of the CEMA on the use of nuclear power for peaceful purposes the coordination scientific and technical council (KNTS-2) was set up for fast reactors. It included representatives of the People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Polish People's Republic, Socialist Republic of Romania, USSR and CSSR.

The main task of the council at that time was to unify the efforts of specialists of the countries to conduct joint work on the problem of fast reactors. The creation of groups, collectives and a material base had the goal of developing and substantiating individual questions linked to the physics, thermal physics and technology of both the fast reactors themselves and their equipment and heat carrier.

In May 1972, at the meeting of the council, the delegations of the countries agreed upon the first plan for cooperation. The joint work began on physical and thermal physical calculations of the fast reactors in the Institute of Nuclear Research and Nuclear Power (People's Republic of Bulgaria), Central Institute of Physics Research (Hungarian People's Republic), Central Institute of Nuclear Research (GDR), Institute of Nuclear Research (Polish People's Republic), Institute of Nuclear Physics (Socialist Republic of Romania), and with the Institute of Nuclear Research and ZSAE [expansion unknown] (CSSR). These same collectives mainly participated in the work on experimental physics.

Specialists of the TsIRI [Central Institute of Nuclear Research] (GDR), TsIFI [Central Institute of Physics Research] (Hungarian People's Republic), IRI [Institute of Nuclear Research] (Polish People's Republic), and the IRI [Insitute of Nuclear Research] (CSSR) took on the development of individual instruments for technological control. The corresponding institutes of the CSSR began to study the questions of designing steam generators.

The next plan of cooperation was approved by the countries in 1976. It provided for the creation of working programs of calculations with regard for different factors, the manufacture and testing of laboratory or experimental-industrial samples of instruments, and the manufacture and testing of steam generator models. In the 8 years of activity of the council scientific collectives have been organized in the fraternal countries and experimental test stands have been constructed. In other words, the scientific and material base was mainly laid for the successful operation in the area of fast reactors. This was promoted a great deal by the conducting of symposiums, seminars, meetings, the work of specialists of the fraternal countries both on Soviet sodium and physical test stands, and on the units BR-10, BOR-60 in the FEI (Obninsk) and NIIAR (Dmitrovgrad). At the meetings of the council that were conducted twice a year, reports were discussed of the specialists from the countries on the course of fulfillment of the planned themes, on the operation of the BOR-60 and BN-350 units, on cooperation and coordination of activity, and rendering assistance to each other in solving individual tasks.

By now, the specialists of the fraternal countries, with the participation of the USSR specialists have finished or are finishing a number of main stages of work. In the People's Republic of Bulgaria, Hungarian People's Republic and the GDR studies are being constantly conducted on evaluating the nuclear data to create a general library. The People's Republic of Bulgaria has set up programs and experimental apparatus to measure and

and pinpoint the neutron constants. The Hungarian People's Republic has made a laboratory model and secondary apparatus that measures the consumption of sodium with the help of heat noises. The GDR has put into operation several experimental-industrial samples of instruments to control oxygen in the sodium and hydrogen in the protective gas, there were tested on the BOR-60 and BN-350 units. The Polish People's Republic has created materials technology channels (loops) for the reactor "Mariya" to test the fuel materials in the heat carrier--dissociating gas. Experiments are being conducted with the automatic admixture indicator on the BOR-60. The Socialist Republic of Romania is organizing a sodium test stand. Verification calculations are being made for the physics and thermophysics of fast reactors. The CSSR is using special stands to study the thermophysical parameters of active zone holders, temperature patterns and heat exchange in the steam generators. One steam generator has been made for the BOR-60 and another for the BN-350. In the NIIAR (USSR) joint searches are being made on the steam generator by the specialists of the GDR, USSR and CSSR. Production has been started in the CSSR and testing in the USSR of individual samples of sodium fittings with a large through section. Based on the formed cooperation, and with regard for the potentialities of the countries, the council in 1979 approved an agreement and long-term target program of cooperation for conducting scientific research and experimental design work on the problem "Development of Fast Neutron Reactor Units of Great Output (with Sodium Heat Carrier and with the Use of Dissociating Gases as the Heat Carrier)." The program includes 12 themes. The specialists of the fraternal countries, based on the technical assignments of the USSR are conducting work on a fast reactor of great output. It is suggested that the new equipment be tested on experimental and industrial reactors.

The agreement and the program approved by the CEMA member countries that are participating in the work of the council promote the creation of a scientific and technical reserve, cooperation and specialization in production of equipment and instruments.

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CEMA COOPERATION IN ELECTRIC POWER HIGHLIGHTED

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 2, 1980 pp 46-52

[Article by Yuriy Savenko, adviser of the USSR permanent delegation to CEMA, and Mikhail Sankov, expert of the CEMA Secretariat: "Cooperation of the CEMA Member Countries in Development of Electric Power"]

[Text] V. I. Lenin placed the victory of the socialist structure in direct dependence on the development of electrification of the national economy as the technical basis of social production. "The only material basis for socialism," he indicated, "can be the large machine industry that is capable of even reorganizing farming. But it is impossible to be restricted to this general conclusion. It needs to be specified. The large industry that corresponds to the level of the latest equipment and is capable of reorganizing agriculture is electrification of the entire country."[1]

Having substantiated the indissoluble tie between electrification and technical progress in all branches of the national economy, V. I. Lenin proved the decisive influence of electrification on the growth of productivity of social labor, that in the final analysis is the decisive factor in guaranteeing the construction of a material and technical base for a communist society.

The development of electrification promotes an improvement in the working and living conditions of the people, and has a significant effect on the formation of the branch structure of social production, the efficient arrangement of productive forces, and the development and perfection of socialist division of labor.

Here the economic expediency of using electricity in a certain region of its use, the most effective level of electrification in a certain country, or branch of its economy at each specific stage of development of social production depend on a whole series of social, technical-economic, and natural-climate factors.

The unification of efforts of interested countries, directly linked to the development of integration processes in their economy plays an important

role in solving the problem of providing for the growing needs of the national economy of the CEMA member countries for electricity (as well as fuel and raw material). An expression of these processes that afford great potentialities for international socialist division of labor is the successive development of economic consolidation of the CEMA member countries that is implemented with regard for the nature of arrangement of productive forces and the proximity of territories of the European CEMA member countries, which is especially important for electric power.

The CPSU Central Committee, after examining and highly evaluating the results of the Crimean meetings and conversations of the General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet, Comrade Leonid Il'ich Brezhnev in 1979 with the leaders of the fraternal parties and countries, noted that the "socialist countries are confidently advancing in their sociopolitical and economic development... At the same time, the socialist countries consider that complication of the world economic conditions creates certain problems for them. In particular, this concerns maintenance of the high attained level of consumption of oil and petroleum products, and guarantee of the steady growth of energy outputs.

By uniting efforts in order to solve problems of power engineering, examples of which are the joint construction of the powerful gas pipeline "Soyuz," the large program for nuclear power plant construction, intensive work to develop new sources of energy, and orientation on the use of the most advanced technology in using traditional resources, the countries of socialist cooperation are creating a stable base for the further growth of their national economy."[2]

About 60 years ago V. I. Lenin wrote that the "modern leading technology urgently requires the electrification of the entire country, and a number of neighboring countries, according to one plan."[3] Currently, under favorable sociopolitical and economic conditions, and the significantly elevated level of technology, this bold outline has distinct contours for realization within the framework of the countries of socialist cooperation.

The scales and rates of development of electrification of the national economy of the CEMA member countries determine the technical and economic directivity of changes in the incoming portion of the electricity balance, i.e., stipulate both the quantitative trends in the growth of the electricity base (mainly sources of electricity generation and their structure), and the potentialities placed in the balance for further increase in its economic efficiency.

The data given in the table testify to the rapid development of electric power in the CEMA member countries in the period from 19[illegible] to 1978.

In 1978, the CEMA member countries generated 1.613 trillion kw-h of electricity, i.e., 21.6% of the world production, while in 1960 their specific weight was 17.6%, and in 1950--13.6%.

Main Indicators of Electric Power Development in CEMA Member Countries

Country	Production of electricity billion kw-h			Rated output of power plants, million kw-h			Consumption of electricity per one resident, kw-h/man*		
	1960	1970	1978	1960	1970	1978	1960	1970	1978
People's Republic of Bulgaria	4.7	19.5	31.5	0.93	4.12	7.98	595	2,290	4,020
Hungarian People's Republic	7.6	14.5	25.5	1.48	2.73	5.54	815	1,720	2,810
Socialist Republic of Vietnam	-	-	3.8	-	-	-	-	-	74
GDR	40.3	67.7	96.0	7.84	12.57	18.86	2,312	3,980	5,760
Republic of Cuba	-	4.9	8.5	-	0.89	2.29	-	574	873
Mongolian People's Republic	0.1	0.5	1.2	0.06	0.22	0.36	112	444	823
Polish People's Republic	29.3	64.5	115.6	6.32	13.89	23.83	995	1,980	3,290
Socialist Republic of Romania	7.7	35.1	64.3	1.78	7.35	14.15	415	1,610	2,870
USSR	292.3	740.9	1201.9	66.72	166.15	245.44	1,360	3,030	4,940
CSSR	24.5	45.2	69.1	5.72	10.81	16.1	1.775	3,380	4,790

*For all countries for the gross production with regard for the balance of export and import of electricity.

Guarantee of the rapid development of electric power in the CEMA member countries is reached to a considerable measure thanks to their joint efforts both on a multilateral, and on a bilateral basis. With the cooperation of the other CEMA countries, for example, in the People's Republic of Bulgaria the thermal power plants of Varna, Devnya, Maritsa-Vostok, Sofia, Bobov-Dol were put into operation; the hydroelectric power plants of the cascades Batak, Vycha, Belmeken-Sestrimo; in the Socialist Republic of Vietnam--the thermal power plant Uong-Bi and the hydroelectric power plant Thak Ba; in the Hungarian People's Republic--the thermal power plants of Dunamenti and D'yend'yesh; in the GDR--Tirbakh, Khagenverder Boksberg; in the Mongolian People's Republic--Darkhan and Ulan-Bator; in the Polish People's Republic--Turuv, Kozenitse; in the Socialist Republic of Romania--the thermal power plants of Borzeshti, Ployeshti, Mintiya-Deva, Galats, the hydroelectric power plant Zheleznyye vorota; and in the CSSR--the thermal power plant Prunerzhov.

Of great importance is the participation of the production and scientific-technical potential of the Soviet Union in the implemented cooperation.

In the current five-year plan the USSR will export to the CEMA member countries roughly 64 billion kw-h of electricity, while in 1971-1975 the export was about 40 billion kw-h, and in 1966-1970--14 billion kw-h. The Soviet Union renders comprehensive support in the development of an electric power base to the countries of socialist cooperation, in particular, by technical cooperation in constructing power facilities on the territory of these countries (by fulfillment of planning work, supply of equipment, carrying out of chief installation and set-up and adjustment work, etc.).

With the technical cooperation of the USSR, a number of CEMA member countries are realizing the planned programs for development of nuclear power. The first nuclear power plants (AES) have been built: in the People's Republic of Bulgaria--Kozloduy, in the GDR--Raynsberg and Nord, in the CSSR--in Yaslovske-Bogunitse. The first AES is being built in the Polish People's Republic and in the Republic of Cuba.

Intensification of the international economic ties in electric power of the CEMA member countries is due to a number of technical and economic considerations. In particular, they include:

--the need to maintain fairly high rates of growth in the consumption of electricity on the condition of a continuous dynamic equilibrium of the processes of its consumption and production;

--nonuniform arrangement of natural fuel and energy resources over the territory of the country;

--technical and economic advantages of the parallel operation of Integrated Power Systems (IPS) of the CEMA member countries.

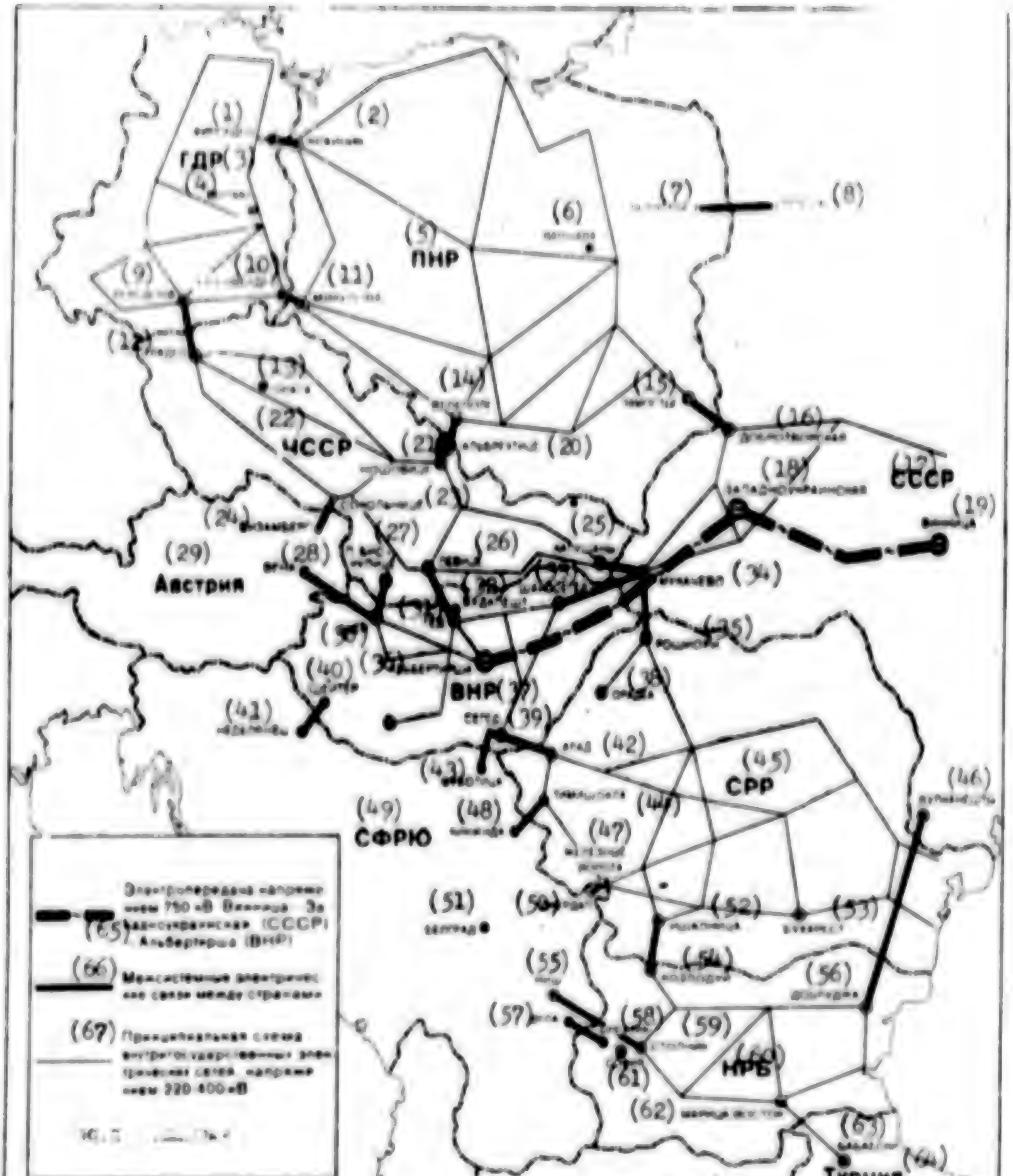
Precisely these reasons determined the primary attention of the countries to questions of multilateral cooperation in the area of electric power within the framework of the Council on Economic Mutual Assistance. The main trends of this cooperation, organized in the permanent commission of the CEMA for electricity, one of the first permanent commissions set up in the Council, are coordination of the national economic plans for the development of the branch and the most important scientific and technical studies in electric power conducted at the suggestsions of the interested countries, question of parallel operation of power systems, exchange of experience in the field of planning, construction and operation of power facilities.

Already at the first meeting of the permanent commission (19-20 March 1956) information was examined of the countries' experience of joint operation of the power systems and exchange of electricity, as well as the available materials and the condition of work to study hydropower resources of the Danube River. And further, questions of multilateral cooperation in the field of organizing and developing the parallel operation of national power systems were in the center of attention of the CEMA member countries. For a more complete use of the technical and economic advantages of the parallel operation of the IPS and coordinated actions of the national state dispatcher administrations, thegovernments of the People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Polish People's Republic, Socialist Republic of Romania, USSR and CSSR in 1962 signed the agreement on the organization of the central dispatcher's administration of the integrated power system (CDA of the IPS).

The process of forming the IPS was governed and accompanied by the development of intersystem power transmissio lines (PTL). By the end of 1978, between the participating countries of the CDA, as well as between them and the Socialist Federated Republic of Yugoslavia there were 31 intersystem PTL, including 1 with voltage of 750 kv, 10 with voltage of 400 kv, and 12 with voltage of 220 kv. The flowsheet for the main electrical connections of the IPS is shown on the figure (see next page).

The total rated output of the power plants that are operating in parallel in the IPS (USSR- West Ukrainian power system), by the end of 1978 surpassed 88 million kw with electricity generation of about 422 billion kw-h.

The exchange of electricity in the IPS between the participants of the CDA in 1978 was 25.7 billion kw-h (in 1970--13.2, in 1960--1.7 billion kw-h). Under interstate exchange of electricity the throughput of the intersystem PTL must provide not only the planned deliveries, but also transmission of power and electricity during emergency mutual assistance, weather disruptions in the operating patterns of the systems, during differences in the passage of the daily and annual maximums of electrical load, drop in required total amount of the reserve output, etc. Precisely these factors mainly determine the formation of an economic effect from the parallel operation of the power systems. Thus, in 1978 the effect from merely combining the electrical load schedules in the IPS exceeded 1170 Mw.



Flowsheet of Main Electrical Networks of Integrated Power Systems (IPS) of European Member Countries of CEMA
[Key on next page]

Key:

1. Firraden
2. Kraynik
3. GDR
4. Berlin
5. Polish Peopl'es Republic
6. Warsaw
7. Bialystok
8. Ross'
9. Rersdorf
10. Hagenverder
11. Mikulova
12. Gradets
13. Prague
14. Velepole
15. Zamost'ye
16. Dobrotvorskaya
17. USSR
18. Zapadnoukrainskaya
19. Vinnitsa
20. Al'brekhtitse
21. Noshovitse
22. CSSR
23. Sokol'nitse
24. Bizamberg
25. Kapushany
26. Levitse
27. P Biskulitse
28. Vienna
29. Austria
30. D'yer
31. God
32. Budapest
33. Shaicseged
34. Mukachevo
35. Roshiori
36. Al'bertirsha
37. Hungarian People's Republic
38. Oradea
39. Seged
40. Sheiter
41. Nedelyanets
42. Arad
43. Subotitsa
44. Timishoara
45. Socialist Republic of Romania
46. Vulkaneshty
47. Zheleznyye vorota
48. Kikidna
49. Socialist Federated Rpublic of Yugoslavia
50. Dzherdap
51. Belgrade
52. Ishalnitsa
53. Bucharest
54. Kozloduy
55. Nish
56. Dobrudzha
57. Vrla
58. Breznik
59. Stolnik
60. People's Republic of Bulgaria
61. Sofia
62. Maritsa-vostok
63. Babayeski
64. Turkey
65. Power transmission with voltage of 750 kv Vinnitsa-Zapadnoukrainskaya (USSR)-Al'bertirsha (Hungarian People's Republic)
66. Intersystem electrical connections between countries
67. Flowsheet of intrastate electrical networks with voltage of 220-400 kv.

The parallel operation of the IPS promotes an increase in the unit output of the power units and power plants, and permits the more efficient use in the countries of the available potential of the power plants of different types.

The development of parallel operation of the IPS to a considerable measure promoted the working out in the countries and agencies of CEMA a number of basic questions of the future development of the branch, and suggestions for cooperation of the interested countries. An important stage in the

further deepening of economic and scientific-technical cooperation in this field was the development within the framework of the permanent commission of a general plan for the long-term development of the integrated power systems of the CEMA member countries, and questions of cooperation in this field in accordance with the statutes of the complex program, including the corresponding cooperation with the power system of the Socialist Federated Republic of Yugoslavia.

Based on the main trends of the general plan, the governments of the People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Mongolian People's Republic, Polish People's Republic, Socialist Republic of Romania, USSR and CSSR on 23 November 1977 concluded a general agreement on cooperation in the long-term development of the Integrated Power Systems of the CEMA member countries for the period up to 1990.

The general agreement is the largest international project that defines the main trends in the coordinated strategy for cooperation of the European CEMA member countries and the Mongolian People's Republic for joint solution of the most important problems in the development of electric power, realization of the possible guarantee of the economically substantiated needs of the countries for electricity in the next decade.

Implementation of cooperation among the countries within the framework of the general agreement assumes the more complete use of national, natural fuel and energy resources to produce electricity,guarantee of the more efficient and economical use of these resources both in production, and in consumption of electricity and heat, including, by means of the broad introduction of central heating, the use of the leading technology and advanced technological equipment in the branches of the national economy.

The CEMA member countries attribute a lot of importance to the potentialities for further development of cooperation on problems of nuclear energy, significant expansion in the future of the use of AES in the electric power balances of the countries. At the AES use of power units is envisaged with perfected water-cooled reactors of unit output up to 1000 Mw (el.). In a number of countries (in particular, in the Socialist Republic of Romania, USSR and CSSR)questions are being worked out that are linked to the combined production of electricity and heat at the AES, as well as the potentialities for separate generation of electricity (condensation AES) and heat (nuclear heat supply plants).

Taking into consideration, that in the near future, as previously, the production of electricity in the CEMA member countries will be based mainly on thermal power plants (currently more than one-fourth of the fuel and energy resources consumed in the national economy in the countries is spent for the production of centrally-generated electricity and heat), it is suggested that the technical level of the classic heat power be significantly raised, in particular, by using highly productive boilers, and the broader use of economical automated power units with unit output of 300,500 Mw and higher.

In relation to the planned program of AES construction, as well as the planned use of thermal power plants with powerful power units, it is suggested that the necessary attention be focused on formation of the optimal structure for the generating facilities in each of the state power systems of the CEMA member countries. For this purpose, the interested CEMA member countries envisage developing cooperation for devising highly maneuverable power units of high output on solid fuel to cover the peak and semi-peak electrical loads, expanding the use of economically justified hydro-power resources, and construction of water storage power plants by joint efforts. They stipulate development and realization of the suggestions for the optimal use of the effect of noncoincidence in individual countries of the hydrometeorological conditions for a possible increase in the dimensions of the guaranteed output and release of energy of the hydroelectric power plants in the state power systems of the CEMA member countries and in the IPS as a whole.

It is planned to conduct a broad program of work on the generating units by the joint efforts of the countries in the area of scientific and technical cooperation, in particular for the creation of MGD--power plants on gaseous, liquid and solid fuel, obtaining of efficient methods for the transformation of solar, wind and geothermal energy into electrical and heat with the development of economical devices and units on this basis.

The main direction for cooperation of the CEMA memember countries in the area of electric power systems is, first of all, a striving for the more complete use of the advantages of parallel operation of the IPS and the creation for these purposes of a network of intersystem PTL of sufficient throughput. It needs to be noted, that in accordance with the studies made during the development of the general plan, the most optimal under IPS development conditions up to 1990 is the use of intersystem PTL with voltage of 750 kv. The general plan provides for the construction of a number of intersystem PTL of the same voltage. The first of them, Vinnitsa (USSR)-Al'bertirsha (Hungarian People's Republic) was constructed and put into operation in 1979. The introduction of this line had a positive effect on maintaining a more stable level of frequency in the IPS, possible implementation of additional planning deliveries of electricity and output. The operation of the first intersystem PTL with voltage of 750 kv permits the CEMA participating countries (People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Polish People's Republic, USSR and CSSR) to realize an effect from the combination of schedules for the electrical load and reserves of electrical output of more than 1300 Mw on the 1980 level.

Construction of the network of intersystem PTL with voltage of 750 kv will permit a guaranteed high level of reliability, controllability, and adaptability of the IPS, and will create the conditions for the most complete use of the intersystem effect that is possible in the presence of these PTL and that, according to the estimates made, is about 4600 Mw on the 1990 level.

As the IPS develops, the exchange streams of power and electricity grow, and new power facilities are put into operation, including those constructed by the joint efforts of the interested CEMA member countries, development and realization are stipulated of a number of measures for cooperation in the field of science and technology as applied to electrical networks. They include, in particular, questions of control and reliable operation of the IPS, creation and development of new, advanced types of electrical engineering equipment, formulation of new methods for transmitting electricity (superconducting and cryoresistive PTL).

As is apparent from the general characteristics given above for the main trends in cooperation of the CEMA member countries that have been reflected, in particular, in the general plan and the general agreement on cooperation in the long-term development of the IPS for the period up to 1990, their realization depends to a considerable degree on guaranteeing the needs of the national economy for reliable and highly economical power and electrical engineering equipment, including that made on the basis of cooperation and specialization of its production in the machine construction enterprises of the CEMA member countries.

Thus, whereas previously the problems of satisfying the needs for electricity in the CEMA member countries were mainly viewed in the framework of the branch coordination of national economic plans and often were reduced only to the adoption of commitments on the isolation of commercial funds for mutual exchange, currently there is a striving for the complex solution of problems of energy with regard for the outlook of common economic development and the main interrelationships with other branches of the national economy, in particular, fuel branches and machine construction. Here, the process of development of international socialist separation of labor in power engineering is shifted more and more directly into the sphere of production, which is characterized by intensification of the effect of extra-economic activity on the intra-economic.

The almost 25-year experience of cooperation of the CEMA member countries in the development and perfection of their economic ties in the field of electric power confirms the correctness of the objective trend revealed by V. I. Lenin towards internationalization of production, the entire political and spiritual life under socialism.[4]

The future decade in which it remains to realize the program of branch cooperation planned by the CEMA member countries in the general plan and the general agreement requires further perfection of its forms and methods.

The General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet, Comrade L. I. Brezhnev in his greeting to the participants of the 33rd meeting of the CEMA session, noted the importance of the task to "turn the next two five-year plans into a period of intensive production and scientific-technical cooperation."

A specific embodiment of this strategy is the long-term target programs of cooperation (LTPC) in key branches of the economy that were approved at the 32nd and 33rd meetings of the CEMA session, and the bilateral documents on long-term development of specialization and cooperation in production; agreement on their development was attained during the Crimean meetings. Such documents on specialization and cooperation of production up to 1990 have already been signed between the USSR and the People's Republic of Bulgaria, Hungarian People's Republic, the GDR and CSSR.

In his speech at the 33rd meeting of the CEMA session, Chairman of the USSR Council of Ministers, Comrade A. N. Kosygin noted, that "development and approval of programs is only the beginning stage of work. We are faced with developing programs into a whole system of agreements that specifically define the conditions and periods of cooperation, and the commitments of the participating countries. It also remains to correlate the agreed upon measures with the coordination of the national economic plans for the next five-year plan, to provide in the plans for the necessary material, financial and labor resources to implement them."

The general plan indicated above for the long-term development of the Integrated Power Systems of the CEMA member countries, including cooperation with the electric power system of the Socialist Federated Republic of Yugoslavia, and the corresponding general agreement were the basis for the energy section of the LTPC to guarantee economically substantiated needs of the CEMA member countries for the main types of energy, fuel and raw material up to 1990, adopted in June 1978 at the 32nd meeting of the CEMA session.

Preliminary developments in the general plan of the main questions for cooperation of the CEMA member countries in the area of electric power permitted the timely beginning of realization of a number of branch measures of the LTPC. As a result of this, for example, in March 1979, on the intergovernmental level a general agreement was signed for cooperation in constructing on the territory of the USSR the Khmel'nitskiy AES, and an agreement on cooperation in the construction and operation of the PTL with voltage of 750 kv from Khmel'nitskiy AES to the substation "Zheshchuv" (Polish People's Republic).

Construction by the joint efforts of the Hungarian People's Republic, Polish People's Republic, USSR and CSSR on the territory of the Soviet Union of the Khmel'nitskiy AES makes a great contribution to the solution of the energy problem in the CEMA participating countries. About 50% of the electricity produced at this power plant, that has rated output of 4 million kw, will be sent to the Hungarian People's Republic, Polish People's Republic and CSSR.

Of especial importance in solving the problems of the long-term fuel and energy balances of the CEMA member countries is the realization of the agreement signed at the 33rd meeting of the CEMA session on multilateral

international specialization and cooperation of production and mutual deliveries of equipment for nuclear power plants for the period 1981-1990. Fulfillment of the commitments of the in this agreement is linked to the realization of the planned program for construction with the technical cooperation of the USSR of nuclear power plants on the territory of the CEMA member countries, whose total output by the end of the decade will be about 37 million kw. This will permit an annual saving of about 70 million T of conventional fuel with normal operational load of the AES.

About 50 major industrial associations and enterprises of 8 countries (People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Polish People's Republic, Socialist Republic of Romania, USSR, CSSR and Socialist Federated Republic of Yugoslavia) will participate in the production and deliveries of the complex equipment that will be implemented in strict accordance with the program of AES construction. Among the organizations are those like the Soviet plant "Atommash," the Czechoslovakian association"Shkoda," the kombinat of heavy machine construction in Magdeburg, the Hungarian association "Khimimash," the Polish "Zemak" and others.

Implementation of the LTPC measures in the area of electric power even now makes it possible to draw a conclusion on their undoubted efficiency for the CEMA participating countries, the possibilities for detection and realization of specific solutions that promote the attainment of the necessary level of supply of the CEMA member countries with electricity with the least outlays of time and social labor. This once again indicates the undoubted national economic importance of the process of development and deepening of the joint planning activity of the CEMA member countries, that becomes a necessary condition for the stable, proportional development of the economy of each of the countries of socialist cooperation. Its introduction and perfection mean the successive development of the Leninist principles for planning a socialist economy and its control at the modern stage.

The decree of the CPSU Central Committee "On the 110th Anniversary of the Birthday of V. I. Lenin" notes that Marxism-Leninism, and socialist internationalism are the basis for the uniting of the countries of peaceful socialist cooperation, that "is in the vanguard of social progress, and is the most dynamic economic and political force, the bulwark of peace and safety of peoples. Life has confirmed the foresight of V. I. Lenin on the diversity of forms and methods of socialist construction in different countries based on the general laws governing the establishment and development of socialism."

As noted in the decree of the CPSU Central Committee, advances in the development of each of the countries of socialist cooperation are indissolubly linked to strengthening of their ideological and political unity, the further deepening and perfection of fruitful, equivalent cooperation in all areas of life and activity. An example of such cooperation is the

interaction of the countries within the framework of the Council on Economic Mutual Assistance, based on the Leninst principles of international solidarity.

FOOTNOTES

1. V. I. Lenin, "Pol. sobr. soch." [Complete Collected Works], Vol 44, p 9.

2. PRAVDA, 18 August 1979.

3. V. I. Lenin, "Poln. sobr. soch., Vol 44, p 280.

4. See, V. I. Lenin, "Poln. sobr. soch., Vol 23, p 318 and Vol 41, p 164.

9035
CSO: 1822

CEMA COOPERATION TO USE NUCLEAR ENERGY FOR CENTRAL HEATING DISCUSSED

Moscow EKONOMICHESKOYE SOTRUDNICHESTOV STRAN-CHLENOV SEV in Russian No 2, 1980 pp 53-55

[Article by Andrey Barchenkov, CEMA Secretariat: "Cooperation of the CEMA Member Countries in the Area of Using Nuclear Energy for Central Heating"]

[Text] At the 32nd meeting of the session of the Council on Economic Mutual Assistance a long-term target program for cooperation in the area of energy, fuel and raw material was approved. This LTPC as the most important measures, in particular, provides for more complete involvement in the economic turnover of the fields of solid fuel (coal and brown coal, lignites, shales, and others), water resources that are available in the CEMA member countries, and the maximum use of nuclear energy.

The general agreement on cooperation of the CEMA member countries in long-term development of the Integrated Power Systems of the CEMA member countries for the period up to 1990 provides for construction of nuclear power plants in the CEMA member countries. Currently, AES's are being constructed in the People's Republic of Bulgaria, Hungarian People's Republic, the GDR, Polish People's Republic and CSSR with the technical assistance of the Soviet Union.

At the end of 1979 the total electrical output of the AES's in the CEMA member countries already reached 15,000 Mw, on which it is planned in 1980 to generate about 70 billion kw-h of energy, which will free about 30 million tons of organic fuel in a conventional calculation.

The active AES's in the CEMA member countries have reached the necessary level of economic efficiency, reliability and safety.

Further development of the scientific and technical cooperation of the CEMA member countries in the area of reactor science and technology and nuclear power engineering to a great measure promoted the growth in the rates of increase in the power outputs of the nuclear power plants. Whereas from 1973 to 1978 the average annual introduction of power output at the AES's of the CEMA member countries was 1400-1500 Mw (el.), in 1979 it reached

[illegible] Mw (el.). This was promoted by the fact that in 1979 two nuclear power units were put into operation with electrical output of 1000 Mw each.

Of great importance for increasing the rates of growth of nuclear power engineering in the CEMA member countries will be the activity of the inter-governmental commission to implement general coordination of the cooperation of interested CEMA member countries and the Socialist Federated Republic of Yugoslavia in realizing the agreement on multilateral international specialization and cooperation of production and mutual deliveries of equipment for nuclear power plants.

Scientific and technical cooperation of the CEMA member countries in the area of nuclear power engineering acquires especial importance due to the planned creation of more powerful, highly efficient and reliable nuclear power plants. And this is closely linked to a number of scientific-technical and planning-design developments for the main assemblies of the power reactor units on thermal and fast neutrons. In accordance with the agreed upon plan of multilateral integration measures of the CEMA member countries in the period of 1976-1980, a lot of work was done in this area. This includes the problems "Creation and Development of Power Units with Water-Cooled Reactors of Output on the Order of 1000 Mw (el.)," and "Conducting of Scientific Research, Planning-Design Work to Create and Develop Fast Neutron Powerful Reactors."

It is further planned to increase the economic efficiency of nuclear power in the CEMA member countries by creating and developing nuclear central heating and power plants (ATETs) and nuclear heat supply plants (AST) for cities and industrial centers.

The development of nuclear power plants, central heating and power plants, and heat supply plants will permit a radical reconstruction of the fuel and energy balance of the CEMA member countries, as a result of which, large volumes of organic fuel will be released.

The General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet, Comrade L. I. Brezhnev in his speech at the November (1979) Plenum of the CPSU Central Committee stated: "It is necessary...to develop nuclear power more rapidly. And not only for production of electricity, but also for the needs of central heating; here there are very perceptible reserves, and this is a very profitable matter."

The main advantage to central heating based on the combined generation of heat and electricity at the thermal power plants (TETs) consists of the fact that here there is a significant reduction in the specific expenditures of fuel for the production of electricity. For turbines with counter-pressure of steam these expenditures are approximately 160 g of conventional fuel per kw-h, versus 340 g of conventional fuel per kw-h on the average for condensation power plants.

A lot of attention is paid to the development of central heating in the Soviet Union.

Currently the TETs satisfy over one-third of the country's need for heat, while the rated total output of the central heating turbines is over 40 million kw with their annual output of heat 900 million Gcal.

Currently, the annual saving of fuel from the use of central heating is about 40 million tons of conventional fuel, and the outlay--over 600 million rubles. Therefore the broad development of central heating will be the most important means for further economy and reduction in specific expenditures of fuel with the combined production of electricity and heat.

In the 10th Five-Year Plan the USSR has envisaged an increase in the output of the TETs for the country up to 77-78 million kw with production of heat about 1.1 billion Gcal per year.

An even greater saving and substitution for organic fuel are reached with the combined generation of heat and electricity at nuclear central heating and electrical plants, or heat--at nuclear heat supply plants.

Thus, the AES equipped with the VVER-1000, in 6000 hours of operation (1 year) with specific fuel consumption of 340 g of conventional fuel per kw-h will replace roughly $2.2 \cdot 10^6$ T of organic fuel in a conventional calculation.

The active ATETs with the same reactor, with a coefficient of central heating of 0.7, equipped with two turbines TK-500-60, by means of recovering heat for the needs of central heating will release roughly an additional 540,000 T of conventional fuel per year. Thus, the complete annual replacement of organic fuel at the ATETs with output on the order of 1000 Mw will be $2740 \cdot 10^3$ T of conventional fuel, instead of $2.2 \cdot 10^6$ T of conventional fuel per year at the AES.

In 1973, the Bilibino ATETs was built in the Soviet Union with output of 48 Mw with production of heat of 100 Gcal/h, and the Shevchenko AES, from which heat is collected for central heating and other needs (freshening of water, greenhouses, etc). The industrial area, residential settlement and heating facilities at the Beloyarsk AES have been centrally heated. The experimental operation of these units proved the possibility of reliable and safe heat supply from the AES. And this makes it possible to define the directions for the further perfection of the central heating complex.

Exceptional importance is attached to the question of using nuclear energy to develop central heating in individual CEMA member countries. For example, in December 1976, in the CSSR a national conference was organized on the theme "Use of Heat from Nuclear Units," in which 230 representatives participated from the Hungarian People's Republic, the GDR, Polish People's Republic and CSSR, as well as the Secretariats of the CEMA and IAEA. Here

suggestions were made on the formulation of measures for the accelerated development of cooperation among the CEMA member countries in the area of central heating from nuclear power units.

Taking into consideration the technical and economic indicators, the design developments of equipment, and the experience of developing the AES, the permanent commission of the CEMA for the use of nuclear power for peaceful purposes at the 39th meeting (1978, Socialist Republic of Romania) approved a suggestion of the working group on reactor science and technology and nuclear power on the expediency of using the nuclear reactor units VVER-440 that were already developed in the work on the AES for the creation of nuclear central heating and power plants, or the VVER-1000 that are in the final stage of development.

The use at the ATETs and AES of reactors of one developed type and the same power not only will increase the relative economy of the ATETs, but also will be one of the significant factors that accelerate the development of central heating on nuclear fuel in the near future. The reason is that here there is no longer any need to develop and master the main and auxiliary equipment of the reactor section of the plant especially for nuclear central heating and power plants. The ATETs to a considerable measure can also use the AES auxiliary equipment with VVER-440 or VVER-1000 units.

The use of a single type of equipment creates conditions for unification of the systems of control and protection, technological, and other systems and arrangements of the plant. The ATETs with turbines of a new type in units with VVER-440 and VVER-1000 immediately after introduction can operate at complete output regardless of the size and rates of growth of the heat loads, giving the generated electricity to the energy system on a par with the AES. Such a feature of the ATETs makes it possible during the planning of construction of industrial-territorial complexes to adopt leading periods of construction of these plants in relation to the periods of construction of the facilities that require heat. This will make it possible to abandon the construction of temporary heat sources on organic fuel, the need for which often arises under modern conditions of the development of central heating.

The constant increase in the thermal load will raise the relative economy of generating electricity at the ATETs all the way to their emergence onto the rated technical and economic indices when the complete calculated load of the ATETs is reached for heat.

In examining the system of heat supply as a unified complex (heat source--heat network--consumer), one should note that to give off heat from the ATETs all the known modifications of the open and closed systems can be employed, since the radiation safety is reliably guaranteed by the employed internal plan of the nuclear heat source.

The permanent commissions of the CEMA for electricity and for the use of nuclear power for peaceful purposes have prepared a program and agreement on the cooperation of the CEMA member countries in the given area. Here they stipulate the development of drafts for ATETs and AST, reduction in outlays for scientific research, experimental design, and planning work, improvement in the technical and economic indicators for heat production, reduction in thermal pollution of the environment and guarantee of the safe and reliable operation of the ATETs and AST.

The program of cooperation of the CEMA member countries on this problem encompasses studies of thermal loads and the development of efficient plans for the use of the ATETs and AST for centralized heat supply in the countries, development of main and auxiliary equipment and construction designs of the ATETs and AST, solution to the questions of safety, including the formulation of criteria of safety and safe arrangement of the ATETs and AST in relation to populated areas, depending on the population size, etc.

Organization of cooperation among the CEMA member countries based on agreements and contracts using the scientific and technical potential of the participating CEMA countries will make it possible to accelerate the solution of important problems of nuclear power included in the LTPC in the area of energy, fuel and raw material.

Within the framework of the permanent commission of the CEMA on the use of nuclear energy for peaceful purposes preparation is underway of a technical and economic report on the effectiveness and scales of application up to 1990 in the CEMA member countries of nuclear reactors for heat supply and the effect of nuclear power on the environment.

9035
CSO: 1822

ENERGY RESOURCES OF THE OCEAN DISCUSSED

Moscow SOVETSKAYA ROSSIYA in Russian 17 Jun 80 p 2

[Interview with Doctor of Physical and Mathematical Sciences Viktor Anatol'yevich Akulichev by V. Anikeyev, Vladivostok]

> [Text] Our age is the age of high speed: the rapid pace of industrial development required large and ever increasing energy expenditures. Competing in their density with the parallels and meridians (which are, as is known, arbitrary lines), a dense network of gas and oil pipelines (man-made and quite real) has engirdled the earth. Coal mines have cut deep into our planet. In 1970, the world energy consumption amounted to about nine billion tons of reference fuel. In all probability, at the end of this year it will be possible to add the same amount: energy consumption doubles every ten years. However, scientists reassure us that this geometric progression is not limitless. By the end of the century, the energy consumption will stabilize at a level of approximately 25 billion tons of reference fuel a year. But even this figure is too high to remain calm: the resources of chemical fuel of organic origin are also not limitless on the earth.

[Question] Viktor Anatol'yevich, scientific and popular press publish diverse information on fuel resources. What figures do you have personally as a deputy director of the Pacific Oceanological Institute? Could you share your information with us?

[Answer] Fuel resources amount to 3800 billion tons. They include 2900 billion tons of coal, 400 billion tons of oil, and 500 billion tons of gas.

[Question] It means that not our distant descendants, but our grandchildren will have every reason to speak unkindly of us. But some people object to giving these figures: why scare people and ruin their mood! Geologists will find new deposits of minerals.

[Answer] They certainly will. This is beyond a doubt. But even that new source will be eventually exhausted. All that nature had created on the earth is not limitless. The epithets "limitless", "bottomless", "boundless" which journalists and some scientists like to use to impress people should have been banned in reference to natural resources a long time ago. So, it is absolutely necessary to sound the alarm. The situation is more serious than it appears to the naked eye. It is better to be a stern realist than a good-natured comforter, because the oil and gas resources could be exhausted in the next few decades.

And how can we fail to recall the basics we learned in chemistry classes at school. I have in mind the statement of Dmitriy Ivanovich Mendeleyev that to burn oil is the same as burning currency bills in a stove. We know all this, have quoted Mendeleyev for eighty years already, but ... continue to burn the black gold. I am sure that the present practice dictated by concrete circumstances and the development level of science will be perceived by our descendants as an unfortunate oddity.

[Question] What should we do for our descendants to think kindly of us? Should we search for replacement of the traditional sources of energy, or harness the thermonuclear reaction and use it in our economy? I am sure that imagination and inspiration of people are capable of offering other worthy equivalents. What principles play the main role here?

[Answer] Whether or not the use of a new fuel is promising depends on its total reserves and the profitability of its production, transportation, and consumption. However, its reserves may not play the most important role. For example, there is more coal than oil on the earth, but oil fields are developed more intensively. Here, the requirements developed by Academician P. L. Kapitsa are very important: a high specific energy content and a considerable density of the energy flux. These qualities are best represented in the systems of nuclear and thermonuclear power engineering. The raw material reserves for them are sufficiently great to meet our energy needs in the course of at least the next few hundred years.

Then other matters of concern will arise. Moreover, nuclear power engineering does not remove, but brings about new very complicated problems. For example, the problem of the protection of the environment against pollution. But let us assume that our old friend, outer space, will come to our rescue, and it will be possible to assemble plants on orbital stations and place there the most powerful consumers of energy for the production of various metals, chemical substances, and synthetic products. But still there will remain many things affecting our ecology on the earth. And we should also think of cleanliness of space.

It is necessary to harness solar energy. It is practically inexhaustible on the scale of our planet. The amount of energy consumed by man today is almost 10,000 times smaller than the heat sent to us by the sun.

[Question] Should we place as many solar batteries as possible on land and in hot regions of the earth?

[Answer] No, that is not what I mean. We should concentrate our attention on such powerful energy sources as the ocean. It is the ocean that can save the honor of the earthlings who have not learned to utilize to the fullest the inexpensive solar heat which is given free to our planet. The ocean is accumulating in its bottomless waters the priceless gift of nature which man did not accept, awating the time when people develop technically and are able to find access to this gigantic accumulator of energy. This energy is not only in the warmth of the heated water masses, powerful currents, and the steady circulation of cyclones. The sun is also responsible to a considerable degree for the eternal movement of surface waves.

This variety of energy sources makes it possible for scientists to try different variants of extracting energy and creating various systems of its conversion. But the most important advantage of the ocean is in the fact that the energy accumulated by it is stable and practically does not change in the course of the twenty-four-hour period. It is very important, because it is possible to do without complex mechanisms which are necessary in solar batteries. This cuts the cost of the operation of oceanic conversion systems to one half or one third. Moreover, oceans are almost everywhere: they occupy 70% of the dry land.

[Question] Please comment on each of the energy sources of the ocean, their potential power, and the possibilities of their practical application.

[Answer] Let us start with thermal sources. The largest amount of energy is contained in the ocean in the form of heat, but it can be used only when there exist working media with different temperatures: high and low. The main thermal resources of the world's ocean are concentrated in the tropical zone. The greatest temperature changes exceeding 24 degrees centigrade have been registered in the western part of the Pacific Ocean between latitudes 30 degrees South and 15 degrees North. This zone stretches along the equator for more than 6000 kilometers.

Along the shores of the USSR and Japan in the Pacific Ocean, average annual temperature differences do not exceed 10-15 degrees centigrade. This is a quite suitable working condition for the production of electric energy.

The first thermal station was built at the end of the twenties in Cuba by a Frenchman, George Claude, after he had conducted experiments on a vessel in the Mediterranean Sea. The modern designs of the converters of thermal energy of the ocean (PTEO) use ammonia or propane as a working fluid in a closed-cycle system. An electric power plant tested in the vicinity of the Hawaiian Islands demonstrated quite convincingly the possibility of creating with the aid of modern technical means a PTEO system of 100,000 kilowatts which is sufficient for supplying energy to a modern city with a population of 100,000 people.

Sea tides have somewhat less energy. However, this type of energy has been used for a long time. In France, a tidal electric power station of about 240 megawatts was built at the mouth of the Rans River.

Other regions of the earth also have the same great potentials. Near the shores of England, in the Bristol Bay, the height of tidal waves reaches 14 meters, near the shores of the USSR in the Penzhinskiy Bay -- about 13 meters, in the Far East, in the Tugurskiy Bay -- about seven meters. In the White Sea, in the Mezen Bay, they reach about nine meters. Much has been written about our tidal electric power station (PES). Studies are being done on the possibilities and expediency of constructing PES in other bays of the Far East.

Large amounts of energy are contained in frequent cyclones and typhoons. However, it is difficult to extract it due to the nonstationery nature of these natural perturbations: when they blow, there is current, when they do not -- there is none. Is it possible to accumulate energy? Probably. But what terminals do we have to use to remove electrical voltage from the typhoon generator? This is the problem of the future generation of scientists. And it is worth the effort. Each cyclone carries the amount of energy equal to that which is released in burning approximately 1000 tons of a chemical fuel.

[Question] The ocean is also a source of hydrogen. There is a billion cubic kilometers of water on the earth. Thank God, as they say, it is more than enough per capita of the population...

[Answer] Yes, it is possible to use the water of the World Ocean for obtaining hydrogen without any limit. And it is possible to organize its production simultaneously with each of the systems which I discussed above... Accumulating hydrogen and transforming it from a gaseous state to a liquid state, it is possible to transport it in special tanker-type vessels. In this connection, systems for transforming thermal energy of the ocean removed to equatorial zones of the ocean far from the main consumers are of special interest. Incidentally, it is also possible to move to the ocean the production of many other products requiring a high energy consumption which use ocean water with dissolved components or bottom rock as a raw material. For example, it is possible to obtain large quantities of ammonia in the ocean by using the same marine hydrogen and nitrogen from the air. It is possible to create metallurgical production and systems for freshening water which is becoming scarcer every year.

[Question] There is no doubt that construction of oceanic electric power stations is very expensive and it is necessary to approach it in an integrated way in order not to build "pyramids of Cheops" in economically undeveloped regions. However, it is time to extract hydrogen from the ocean in considerably greater quantities than has been done so far. It has already proven its ability to turn the wheels of automobiles in place of gasoline, the price of which increases at the rate that gasoline is poisoning the atmosphere.

[Answer] A large number of explosionproof and harmless hydrogen engines have been developed. Only its combustion by-product, nitric oxide, is undesirable, but hydrogen engines produce only one-tenth of the amount released by the most modern engines. Recently, a hydrogen automobile was tested in Khar'kov which required two and a half kilograms of hydrogen per 350 kilometers.

[Question] Is it possible that intensive exploitation of the ocean might lead to grave ecological consequencies?

[Answer] Scientists are also concerned about it. In any case, they should be concerned. There are all prerequisites for the oceanic energy to be the cleanest of all types of energy used by man. However, we, undoubtedly, must be careful. This refers particularly to systems for converting thermal energy when large amounts of cold water will be rising to the surface from the depth. Rich in nutritive substances, it can serve as a raw material base for developing fisheries, marine culture, or aquatic culture in these regions. However, it could be that when microorganisms living in deep water are raised to the surface, they will pollute the ocean and it will be necessary to implement special measures for purification. The creation of PTEO systems will require to develop fundamentally new techniques using the most modern synthetic materials. However, very complicated problems may, evidently, arise in the area of politics and international relations.

At the present time, energy sources of the ocean are, probably, the only sources which do not belong to any particular countries. The highest energy potentials are concentrated in the equatorial areas of the World Ocean which are owned at the present time by all people. So far it is not quite clear how energy consumers from various countries will be distributed in these regions of the ocean, who will regulate its consumption and who will control its ecological purity. Creation of accident-prevention services and special emergency services also presents a complicated problem.

[Question] What concrete information about the harnessing of the energy of the ocean can be obtained today in your institute?

[Answer] A special laboratory of phase and energy transformations in the ocean is operating within the Pacific Oceanological Institute. It is planned to create in the USSR a demostration system transforming thermal energy of the ocean into electric energy with a capacity of 500 kilowatts. It will be installed aboard the research vessel of the DVNTs [Far Eastern Scientific Center] of the USSR Acacemy of Sciences "Kallisto" and will be ten times more powerful than the analogous American station operating in the Hawaiian Islands. We are working on this jointly with the Institute of Thermophysics of the Siberian Branch of the USSR Academy of Sciences and the Power Engineering Institute imeni G. M. Krzhizhanovskiy. We have compiled a collection of articles "Energy of the Ocean"...

[Question] Articles...

[Answer] Yes, of course, we should hasten with the building of electric power stations in the ocean. While you and I are talking about the possibilities of extracting energy from the oceanic no man's depths, how much oil flowed into the pipelines and how much coal was burned!

10,233
CSO: 1822

URBAN CENTRAL HEATING PLAGUED BY INEFFICIENCIES

Moscow PRAVDA in Russian 28 Apr 80 p 3

[Article by Miroslav Buzhkevich: "The Warmth of a City"]

[Text] Not a day goes by without the editorial board of PRAVDA receiving letters about heating and hot water supply in residential buildings. Letters come from northern Arkhangel'sk and southern Odessa, far away Chita, and from right next to the capital in Penza. Letters come in winter and summer. Noting with satisfaction the constant development of central heating and the growing comfort of life, readers concurrently state many valid complaints. Their essence may be boiled down to the following questions, not at all rhetorical: Why do the radiators supply an overabundance of heat in fall and spring, and on occasion barely keep themselves warm in winter, and who is responsible for the quality and uninterrupted supply of heat? We will try to unravel at least some of the causes of the shortcomings in heat supply.

This Was Not the Original Idea

There are no equals in world practice for the scale of central heating afforded to the housing pool of our country. Swift growth of the traditional industrial centers and arisal of hundreds of new cities have predetermined swift formation and expansion of the central heating system. Today it embraces about 70 percent of the country's public housing pool, more than 80 percent in the RFSFSR, and it has attained a ceiling--100 percent--in Angarsk, Novopolotsk, and Volzhsk. Various ministries and collectives of major scientific research and planning-design organizations are involved in the organization of central heating. A program for development of this sector in the European SSR, intended to go into effect over the next few years, is already being implemented, and a similar plan is being developed for all of the country's territory.

The technical policy of thermal power production has concentration at its core, which is economically extremely advantageous, and which also reduces atmospheric pollution. Today, together with several thousand regional boiler plants with an output capacity of more than 20 gigacalories, the USSR Ministry of Power and Electrification's 1,500 TETs's are producing about 60 percent of the country's heat, with the remaining 40 percent being produced by more than 120,000 small thermal power sources.

And so, we must force concentration of thermal power engineering. This is the concern of the USSR Ministry of Power and Electrification, communal organs, and local soviets. It is believed that the successes here are self-evident. According to estimates of the All-Union Scientific Research and Planning Institute of Power Engineering Industry, more than a million workers employed at small, presently shut-down boiler plants have been freed for other work and not less than 130 million tons of comparison fuel have been saved in the Ninth Five-Year Plan due to centralization of heat supply. However, this information is clearly not in keeping with data from the USSR State Statistical Administration, according to which the number of boiler plants in the country grew by more than 25,000 in the same time period. This trend can also be seen in the present five-year plan.

Paradoxical, is it not? Officially, the small heat sources are "outside the law"--it has been decided to shut them down completely with time, but they continue to be fruitful, and multiply at undiminishing speed. Strange as it may seem, this phenomenon can be explained in elementary terms. For various reasons, thermal power output capacities totaling more than 5 million kilowatts have not been put into operation in the last 10 years. Dozens of TETs's have not achieved their full power, or their construction has not even been completed. Due to this about 500 boiler plants, to include 495 small ones, have appeared in Kuybyshev, Voronezh, Odessa, and Sumi. Their "birth" and existence have cost the state 60 million rubles of additional capital investments, and significant overconsumption of fuel. Sometimes it also happens that a finished TETs built in a new microregion is not outfitted with heat supply lines yet. There is no time to wait for their installation, since the housing must be occupied. And so the dwarf boiler plants arise.

The city heat supply development master plans were to be an important means by which to accelerate concentration of the production of hot water and steam. But alas, their role is for the moment inconsequential: They do not as yet have the same binding force as do master plans for industrial center buildup. And therefore they are not fully implemented, and sometimes they are changed arbitrarily. Out of the planned 17, only 3 boiler plants have been built or rebuilt in the past decade in Stavropol'. At the same time 42 heat supply sources not foreseen by the master plan have appeared. Such "do-it-yourself" ventures have cost the state almost 4 million rubles. To make matters still worse, the thermal power supply master plans are being written all too slowly. An entire collection of permits--about 25--must be accumulated before a plan is "brought up to spec," which requires the time of many developers. If the work on the plans is not accelerated, the

country's cities will not receive them until the beginning of the next century. That is clearly a long time to wait. Will the USSR Ministry of Power and Electrification and the republic ministries of housing and municipal services think about how to reduce this time?

The River Runs Dry

In contrast to fuel, thermal energy cannot be saved for a rainy day. Hot water must constantly circulate in the heating system; it is only in this way that it can warm a house. This feature makes the problem of its transportation from its place of production to the radiators in our apartments extremely acute. It is not a short road. Before it comes to its end, this river of heat "runs dry."

The first section consists of the network of mains leading from the TETs's belonging to the USSR Ministry of Power and Electrification. Their efficiency is believed to be more or less adequate, though the losses due to poor insulation are several percentage points here. Pipe corrosion does a great deal of harm. It is the cause of four-fifths of the mishaps in the main networks. Scientists have created several means of protecting metal against destruction. One of them--enameling the pipes--was approved as much as 20 years ago. However, the program for building the special shops required for this purpose has never been implemented. The method was never introduced into practice. Another way--covering the pipes with organosilicate paint--is not for the moment realistic: The paint does not exist yet. To put it more briefly, the problem of dependable anticorrosion protection is extremely pressing.

The main heat losses occur in the sections managed by municipal power engineers, local soviets, and housing administrations. The dimensions of these losses have never been clarified--even in the State Statistical Administration; these statistics simply do not exist. According to some estimates they make up 10-12 percent, while according to others they are 15-20 percent. If we take the mean of these figures, we would find that tens of millions tons of fuel are wasted each year to "heat the sky." In the expressive words of one power engineering expert, the distribution and residential block networks and the residential heating systems are a huge barrel without a cock--the contents pour out of it freely. The sad part about this is that these words are not an exaggeration. While we know how much hot water or steam is produced by TETs's and by large boiler plants, it is impossible to determine how much reaches the consumer. There are no instruments to account for heat consumption in the sphere of residential and municipal services.

This problem is not new. Almost 10 years ago the USSR Ministry of Instrument Making, Automation Equipment and Control Systems and the State Committee for Urban Construction were ordered to develop, by 1974, instruments and automatic control systems for heat networks. A heat consumption meter was ready 4 years ago, but its production has still not been started up. This is why enterprises

of the RSFSR Ministry of Housing and Municipal Services' Main Power Engineering Administration will receive only a few hundred such instruments, instead of the 60,000 they need this year. It would be pertinent to note that material-technical supply of enterprises in municipal power engineering does not satisfy even the minimum needs. In the Russian Federation, as an example, they are receiving practically no piping at all to repair their heating networks. The same can be said for pipe fittings. Thus we can understand why the losses experienced by these networks are so great.

Optimum heat consumption depends on its distribution as well as on the adjustment of residential heating systems. In a cold apartment, people usually catch colds. But if a room is heated one degree above normal, fuel consumption increases by 3-4 percent. People in upper stories open up their air vents, and even their windows, due to which it becomes colder in apartments lower down, from which the warm air rises to the roof. Another situation may also arise--if too much hot water is sent to a building located near the heat source, neighboring buildings have nothing left with which to raise their temperature to the standard level, and the people freeze. Adjusting a residential heating system and making heat supply uniform to all buildings is a difficult operation requiring deep engineering knowledge and experience. And yet this is usually done by fitters employed by the housing operation offices and housing administrations, ones who sometimes have no facility with the principle of operation of various consumption limiting resources. Moreover there are no automatic control resources available yet.

But why even talk about automated resources? The conventional cocks used to reduce or increase the admission of heat into radiators have almost completely disappeared. They are being produced in much fewer numbers than required. Moreover a significant proportion of these simple devices are improperly designed, and they are not made of the correct materials. They leak, and they break down. Only one of the plants of the Moscow City Executive Committee has assimilated production of a dependable brass cock, but it is unable to cover the demand. And if we were to speak frankly, such cocks represent antiquated power technology. Radiator thermostats have long been in extensive use in a number of countries.

Repair services also sometimes find themselves in a difficult situation. For the moment urban distribution and residential block networks do not possess central control consoles. Due to the lack of information concerning the status of individual sections, the breakdown locations are sought for blindly, valve by valve. And so it takes a long time to correct problems, which sometimes leads to woeful consequences, going as far as interruption of services to residential heating systems.

Heat "Overconsumption" Due to "Underconsumption"

And so, it is spring in the streets, but the radiators are hot. We become perturbed, and we telephone the housing operation office and the rayon

housing administration. But we are simply spinning our wheels. No one involved in heat supply is interested in fuel economization or is fully responsible for the quality of heating. In many ways this is the product of the planning indicators by which the thermal power enterprises are judged. A decrease in hot water and steam production at TETs's of the Ministry of Power and Electrification threatens an overshoot in unit consumption of fuel for production of electric power; this does away with all hope for material stimulation.

The amount of heat supplied is the main indicator by which municipal power engineers are judged. If the plan is not completed, there can be no hope for a bonus. Moreover the engineers are not permitted to adjust monthly assignments in accordance with mean outside temperature. And if the winter was not so cold, "underconsumption" must be compensated for by "overconsumption" in spring.

It is of course difficult to change planning indicators. But the change must be made. The volume of heat supplied--one of the old "gross" indicators in new clothing--has long compromised itself as a yardstick, and it no longer has a right to serve as the main criterion by which to judge the work of any enterprise, including boiler plants. Responding to the voice of the scientists and the organizers of heat supply, can we not adopt unit consumption of fuel per gigacalorie as the basis, and introduce an assignment correction factor depending on mean monthly temperature?

Let us now descend to the basement of the home, to the so-called utility level, and talk with the fitter, who is responsible for turning the heat to our apartments on and off. Naturally, he as well would like to receive his bonuses regularly. And he will receive them if the residents do not make any justified complaints about the heating--so reads one of the items of the provisions approved by the USSR State Committee for Labor and Social Problems and the AUCCTU more than a decade ago. Thus it is not enough for a resident to say that his radiators are cold; he must also prove that he is right. The unacceptability of the evolved situation is obvious. However, objective ways for assessing the labor of workers at the bottom level of housing management have not been arrived at yet.

The problems of control are no less important. The way experts see it, although the heat supply system has already been in existence for many years, it has still not transformed into a single strong chain, being instead a conglomerate of assorted links. The power sources in the networks belong to numerous owners. Each of them operates the systems on the basis of their own interests, sometimes showing no concern for the common good. Many ways for eliminating this dispersal are being suggested. People in the Ministry of Power and Electrification wanted to limit their functions to production of heat. Let the ministries of housing and municipal services and the local soviets worry about transporting it from the TETs to the apartments. The municipal power engineers, meanwhile, view the urban heat supply from a different aspect--they see it as two rivers. One of them goes from the TETs

to the radiators in the residential buildings, and it is maintained by the Ministry of Power and Electrification, while the other is within the hands of the governing boards of the united boiler and thermal networks of the ministries of housing and municipal services. The egoistic nature of these proposals is obvious--their authors are more concerned with making their own tasks easier than with improving services to the public.

In our opinion the work that has been done by scientists of the Academy of Municipal Services has reached closest to the target. They feel that a ring heat main that connects to all TETs's and major boiler plants should be created in the city. The obligation of the heat suppliers is to deliver hot water and steam to a control and distribution point in each microregion. The servicing of this point, and subsequent transportation and distribution of the heat, until such time that it reaches the radiator, is the responsibility of specialized municipal power engineering subdivisions subordinated to the local soviets. The work of these subdivisions could be structured on the team contract principle, which would raise the material interest and responsibility of the engineers, technicians, and fitters. This system would insure precise adjustment of housing heating systems and their prompt repair, and it will insure maintenance of the network.

There may be other variants as well. What is important is to not postpone solution of the problems of heat supply management until tomorrow. Organized heating and supply of hot water to baths and to kitchens means the good health, mood, and working ability of tens of millions of laborers, their children, and elderly parents. Creating the most favorable conditions for the life of Soviet people is our common concern.

11004
CSO: 1822

BETTER THERMAL ENERGY SALES INDICATORS SOUGHT

Moscow EKONOMICHESKAYA GAZETA in Russian No 21, May 80 p 4

[Article by Engineer-Economist M. Semenushkin, Lecturer F. Tagi-Zade, and Prof E. Turchikin: "When the Economy Operates at a Loss"]

[Text] In our opinion we cannot successfully solve the problem of stimulating the thermal power economy, raised by readers of EKONOMICHESKAYA GAZETA in the "Enterprise Economist" department (No 28 and 36, 1979), without eliminating the basic contradiction in the economics of thermal power engineering enterprises. It can be stated as follows: in view of the unique features of thermal power production, it is always advantageous for thermal power enterprises to increase delivery of thermal energy to consumers, and it is always disadvantageous to reduce it.

Given stable rates and a relatively constant structure of heat loads, growth in income and profit may proceed only in response to additional production of thermal energy. Increased production of thermal energy has a favorable effect upon all technical-economic indicators of the enterprise: It raises the load and the degree of use of production equipment, it reduces unit consumption of fuel and electric power, it decreases production costs, and it raises the profitability of production, while a decrease in delivery of thermal energy to consumers produces the reverse result--that is, a worsening of the enterprise's economic indicators.

The planned amount of thermal energy produced and delivered to heat buildings cannot be determined arbitrarily, and it must correspond strictly with the estimated (standard) needs of the buildings supplied by the given system. However, subjective interests encourage the collectives of thermal power enterprises to plan increases in delivery volume in lieu of any additional growth in heat demand, and to surpass the delivery plans in detriment to national economic interests and to sensible use of fuel and energy resources.

The existing economic indicators, levers, and stimuli, to include those proposed by the Main Power Supply Administration of the Ministry of Housing and Municipal Services for economic experiments, in our opinion not only fail to eliminate the interest in delivering thermal energy in excess of the

plan (of the standard), but on the contrary they intensify it, creating a favorable situation for thermal power enterprises and having an unfavorable effect on economization of fuel and energy resources.

How do we solve this problem?

In our opinion we would first have to deprive thermal power enterprises of the economic advantage they enjoy from above-plan deliveries of thermal energy. Second, we need to create conditions under which economization of thermal energy (elimination of above-standard expenditures) would not mean a loss to the enterprise, being instead an economically advantageous measure to it.

This can be done by changing the existing order of paying for thermal energy released to consumers. Presently the income of thermal power enterprises is formed out of payments, based on approved rates, for the amount of thermal energy actually sold. A planned delivery amount, computed from data describing the estimated load of attached consumers, which is fixed in thermal power delivery contracts, is to be paid for on the basis of existing rates.

If the actual quantity of thermal energy sold turns out to be less than the planned amount, the enterprise returns, to the consumers, part of the paid sum equal to the cost of the saved fuel and energy resources (the conditional, variable part of the outlays). In precisely the same way, if the actual volume sold is greater than the planned amount, consumers pay the enterprise an additional amount equal to the cost of fuel and energy resources consumed in excess (as defined by the planning estimates).

This form of payment for thermal energy released to consumers insures agreement of the interests of consumers and the enterprise, and it encourages them to try to eliminate above-standard expenditures of thermal energy, and to develop and implement measures aimed at reducing standard consumption of thermal energy to heat buildings.

However, in order that the actual profit would not be less than that planned, the enterprise would have to seek out and make use of internal reserves, and improve its operations. It is only under these conditions that the indicators for growth in profit, reduction of production costs and of the norms for expenditure of energy resources, and reduction of losses in thermal networks acquire the significance of stimulatory factors.

The new form of consumer payment requires isolation, within the rates for thermal energy, of the amount of standard outlays on fuel and energy resources, which would make it possible to introduce standard net production and other indicators computed on this basis into the system of enterprise economic indicators.

11004
CSO: 1822

POWER LINES CONNECT EKIBASTUZ TO DISTANT POWER CONSUMERS

Moscow SEL'SKAYA ZHIZN' in Russian 13 Jun 80 p 1

[Article: "Superpowerful 'Rays' From Ekibastuz"]

[Text] The alternating current LEP-1150 [1,150,000 volt electric power transmission line] will improve the energy budget of the Urals and contiguous regions, and do away with the need for further rail shipments of tens of millions of tons of coal for electric power production. The first prefabricated reinforced concrete foundations for the steel towers have been installed in the first section of the mainline between Ekibastuz and Kokchetav.

Having nothing similar in world practice, this line is intended to operate at a voltage of 1,150,000 volts. It will extend latitudinally for a distance of almost half a thousand kilometers. The purpose of the mainline is to carry energy from Ekibastuz thermal power plants, the first of which is already operating, to the Urals. The LEP-1150 will cover the maximum evening loads of the power systems by transferring an additional quantity of electric power from Ekibastuz, where night would already be setting in at this time.

The program for creation of the Ekibastuz fuel and energy complex foresees laying a "fan" of high and superhigh voltage LEP's from it to different regions of the country. The first 500 kilovolts "rays" have already tied it in which Siberia, Altayskiy Kray, central and east Kazakh SSR, and the southern Urals.

11004
CSO: 1822

BRIEFS

KOLYMSKAYA GES--There were only 40 people in the construction administration of the Kolymskaya GES at the end of 1969. Now the hydroelectric power plant builders' town of Sinegor'ye has a population over a thousand. Moreover, 37 nationalities of our country are building the Kolymskaya GES. In the fourth year of the five-year plan the cost of jobs completed in excess of the general contract was 14 million rubles. The hydroelectric power plant builders have put the LEP-220 power transmission line, about a thousand kilometers long, into operation, and they have built a bridge across the Kolyma, an airport, a school, a hospital, two children's combines, and a hotel. In the concluding year of the five-year plan the builders have pledged to complete 18,000 square meters of housing space, a communication center, and dispensaries for the hydroelectric power plant builders, and of course to place the first machine unit into operation ahead of schedule. At the beginning of April of this year a giant motor column arrived at the construction site of the Kolymskaya hydroelectric power plant after a 500-kilometer journey along the Kolyma. It delivered a 300-ton flatbed car carrying a transformer. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Apr 80 p 1] 11004

NOVOVORONEZHSKAYA AES--Voronezh, 31 May--The fifth power block, with an output capacity of a million kilowatts, began producing industrial current today at the Novovoronezhskaya Atomic Electric Power Plant. "Its commissioning is a great labor victory for builders, installers, operators, scientists, and specialists," said electric power plant director V. Sedov. "The country's first atomic water-cooled million kilowatt reactor was installed here. The new power block, which embodies the latest achievements of science and technology, will become the standard for AES's erected in the USSR and in other CEMA countries. It differs advantageously from its precursors not only in output capacity but also in design and operating convenience. While it takes 10 turbines in the first three of the station's blocks to produce a total of a million kilowatts, it only takes two to do so in the fifth. While the volume of the active zone of the new reactor has been enlarged insignificantly, its energy payoff has more than doubled. Now the output capacity of the AES on the Don has attained almost 2.5 million kilowatts. The 15 years of operating experience at the Novovoronezhskaya plant, which has already produced more than 85 billion kilowatt-hours

of electric energy, have demonstrated the high effectiveness of the domestically-produced equipment, and the dependability of all control and radiation protection systems. [Text] [Moscow SOVETSKAYA ROSSIYA in Russian 1 Jun 80 p 1] 11004

SHUL'BINSKAYA GES--Semipalatinsk--An important phase of the work has begun in construction of the Shul'binskaya GES. The lower dam has been completed, and the foundation pit for the power plant building is now being dried. The builders of the GES have assumed a shock pace. The competition for the right to lay the first cubic meter of concrete in the body of the dam has taken on broad scope. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 24 May 80 p 1] 11004

POWER GENERATORS--Mobile diesel electric power plants of a new type created by the Leningrad Zvezda Association are capable of supplying energy to a large town. The first models of such machine units, which produce over 600 kilowatts, have been sent to Tyumenskaya Oblast. The main advantage of the new unit over the diesel generators supplied to the oblast in former times is their modular execution. To make such an electric power plant operational, a foundation need not be installed, and a special building need not be erected. The plants are transported from the manufacturing enterprise to their place of operation in special boxes, completely ready for work. "There is only one obstacle keeping us from sending the new units to oilmen and gasmen of Tyumenskaya Oblast: The Ministry of Construction of Petroleum and Gas Industry Enterprises is not supplying crates of the needed quality to the Leningrad builders," said A. Viksman, chief of the firm's design division, to a TASS reporter. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 May 80 p 2] 11004

LEP-1150--The LEP-1150, an alternating current transmission line, will improve the energy budget of the Urals and adjacent regions, and eliminate the need for shipping tens of millions of tons of coal for power production by rail. The first prefabricated reinforced concrete foundations for the high-voltage steel towers were installed in the first section of the mainline between Ekibastuz and Kokchetav. Having no analogs in world practice, this line is intended to carry one million one hundred fifty volts. It will extend latitudinally almost 1,500 kilometers. The purpose of the mainline is to carry power from Ekibastuz thermal power plants, the first of which is already operating, to the Urals. The LEP-1150 will cover the evening maximum loads of the power systems by transferring an additional amount of electric power from Ekibastuz, where night would already be setting in at this time. The program for creating the Ekibastuz fuel and energy complex foresees laying a "fan" of high and superhigh voltage LEP's from it to different regions of the country. The first 50-kilovolt "rays" have already joined it to West Siberia, Altayskiy Kray, central and east Kazakh SSR, and the southern Urals. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Jun 80 p 2] 11004

WRONGDOINGS ADMITTED--USSR Deputy Minister of Power and Electrification N. Ivantsov--The article "Light and Shadow" published in your newspaper on 13 February 1980 was discussed by the administration of the USSR Ministry of Power and Electrification. The criticism addressed to the management of "Kolymagesstroy" was recognized to be correct, and the newspaper's discussion of the style of management afforded to the remote construction site, and of the need for creating a healthy atmosphere there, was assessed as timely and important. The situation at the construction site and the work style of construction chief Comrade Frishter, party committee secretary Comrade Pavlov, and building committee chairman Comrade Mikhnovets were discussed by the Magadanskaya Oblast CPSU Committee and by the Yagodninskiy Rayon CPSU Committee. Comrade Frishter was reprimanded and comrades Pavlov and Mikhnovets were released from their posts and dropped from CPSU membership. It should be noted that in essence, construction of the Kolymskaya GES was in essence a great production experiment intended as a means for working out the principles for construction of large hydroelectric power facilities in uninhabited regions of the Far North. A good production base and a well-outfitted town have been built here. Great credit for this belongs to Yu. Frishter, the chief administrator of the construction project. However, as was validly noted in the article, good indicators of economic activity and concern for the construction project as a whole do not give an administrator the right to forget about the individual laborer, and all the more so to violate socialist legality. This is what was discussed in the article. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 5 Jun 80 p 2] 11004

LEP-500--Krasnoyarsk, 1 Apr--The towers of the second LEP-500 have now stepped across the mountain passes and gorges from the Karlo section of the Yenisey, the site of the Sayano-Shushenskaya GES, to the substation of the young city of Sayanogorsk. And although this line is only 32 kilometers long, the team of installers headed by A. Martynov required considerable skill, courage, and self-sacrifice in order to complete construction of the electric power line precisely on schedule in the difficult conditions. The new LEP-500 will carry current from the third and fourth machine units of the hydroelectric power plant, which is to begin operating this year. And electric power engineers are starting to mark out yet another power route--from the Sayano-Shushenskaya GES to the Kuznets Basin. [Text] [Moscow PRAVDA in Russian 2 Apr 80 p 2] 11004

ATOMIC POWER PLANT PROTOTYPE--An experimental thermal power plant with a reactor using an organic heat carrier has been put into operation at the Scientific Research Institute of Atomic Reactors imeni V. I. Lenin in the city of Dimitrovgrad. Its output capacity is 5,000 kilowatts. It will become the prototype for low-power plants operating in remote regions of the country. Commissioning of the new atomic power plant is just one of the many projects of the institute's scientists associated with the use of atomic energy for the purposes of thermal power supply. Its commissioning was preceded by many years of experience in successful operation of the water-cooled VK-50 boiling-water reactor and the Arbus reactor using an organic heat carrier. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Apr 80 p 4] 11004

NEW POWER LINE--Stavropol', 14 May--The metallic towers of the LEP-500, which will join the Inguri GES to the Stavropol'skaya thermal electric power plant, have now risen beside the city of Karachayevsk. A significant part of the electric power transmission line's 417 kilometers pass over mountainous and rough terrain. The high point--Makharskiy Pass--is about 3,000 meters above sea level. The assault upon this point was started by the collective of the Tbilissi Kavkazelektroset'stroy Trust. It was impossible to use cargo helicopters in the transport operations due to the thinness of the air. Motor and tractor roads are being laid to the places of tower installation. There are also difficulties associated with crossing the mountain rivers. There are sections in which the spacing between towers attains 1,730 meters. The new route will unite the power systems of regions such as the Caucasus and the country's south and center. [Text] [Moscow PRAVDA in Russian 15 May 80 p 2] 11004

MORE ON NOVOVORONEZHSKAYA AES--The fifth million kilowatt power block containing a water-cooled vessel reactor has become operational at the Novovoronezhskaya Atomic Electric Power Plant. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 23, Jun 80 p 3] 11004

RYAZANSKAYA GRES--Assembly of the fifth turbogenerator of the Ryananskaya GRES, which has an output capacity of 800,000 kilowatts, has been started. After the fifth machine unit is placed into operation, the output capacity of the GRES will be 2 million kilowatts. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 22, May 80 p 3] 11004

THERMAL POWER PLANTS--In cooperation with its associates, the Volgoenergomontazh Trust has commissioned a boiler with a productivity of 420 tons of steam per hour at the Volgogradskaya TETs-3 a month ahead of schedule. A power block consisting of a 160,000 kilowatt turbine and a boiler producing 500 tons of steam per hour has been placed into operation 2 months ahead of schedule at the Nizhnekamskaya TETs-2. [Text] [Moscow STROITEL'NAYA GAZETA in Russian 15 Jun 80 p 2] 11004

BRATSKAYA GES--Bratsk (Irkutskaya Oblast)--The Bratskaya GES imeni 50-letiye Velikogo Oktyabrya has completed production of 350 billion kilowatt-hours of electric power since the first machine unit was placed into operation in 1961. The power giant on the Angara has already produced a seven-fold return on its erection. The effectiveness of the largest GES of the Angara cascade has risen significantly, now that the equipment has been modernized. The favorable example contained in this work was noted in a recent conference of the CPSU Central Committee devoted to the problems of power engineering development. Jointly with specialists of the "Leningradskiy Metallicheskiy Zavod" and "Elektrosila" associations, the operators of the hydroelectric power plant rebuilt the turbines and the generators of the Bratskaya GES and increased the plant's output capacity to 4.5 million kilowatts. This made it possible to produce more than a billion kilowatt-hours of cheap electric power in excess of the plant. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 21 Jun 80 p 1] 11004

GIANT TRANSFORMERS--Erection of the first generation of a complex manufacturing superpower machine units has begun in the Zaporozhtransformator Production Association. It will build unique equipment for superlong electric power transmission lines carrying 1,150 kilovolts. Giant transformers with an output capacity of 2 million kilovolts will become the basis for creating the "Siberia-Center" energy bridge. This is the first time such a scientific-technical task is being tackled in world practice. The new high-power machine units will be delivered to their place of work by water. This can be explained not only by the overall dimensions and weight of the transformer, but also by the fact that the energy producers are located on rivers. [Text] [Moscow IZVESTIYA in Russian 1 Jun 80 p 1] 11004

CSO: 1822

GRAYFER: PLANNING IN THE OIL INDUSTRY OUTLINED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 May 80 p 2

[Article by V. Grayfer, chief of the economic planning administration and member of the collegium of the Ministry of the Petroleum Industry: "Using the Criterion of Efficiency"]

[Text] The decree of the CPSU Central Committee and USSR Council of Ministers on refining the economic mechanism said that the system of measures and indicators provided by this document applies to all sectors of industry and to capital construction. At the same time, the decree emphasizes that in the extracting and certain other sectors there may be particular planning-evaluation indicators that reflect the dynamics of production, increase in efficiency, and growth of labor productivity more accurately.

My colleagues, executives in the administrations and all-Union industrial associations of the Ministry of Petroleum Industry, often complain that the difficulties which they run into have less to do with solving complex production problems than with overcoming various types of "blunders" in the system of the economic mechanism. This is indeed true. An incorrectly chosen planning-evaluation indicator and the lack of necessary economic levers and stimuli lower and sometimes completely nullify the effectiveness of administrative measures that are taken.

For example, let us take one of the most common types of work at oil fields, underground well repair. An indicator called "number of repair jobs per brigade per month" existed for planning, evaluation, and material incentive for repair workers. At first glance this seems entirely logical: if a worker did more repair jobs, this means he worked better. But let us take a closer look.

In such a situation the underground repair brigades and shops are objectively interested in having a constant reserve of wells needing repair. They might overfulfill assignments, receive bonuses, and occupy the winner's circle in competition, but this would not be

reflected at all in the final result, the level of fuel extraction. On the other hand, the more wells are down for repair, the less petroleum the field will recover. The interests of the extraction workers and the repair workers did not coincide. All this recalled the well-known parable of the glass worker who broke windows at night to give himself a "work front" for the next day.

The Bashneft' [Bashkirskaya ASSR Petroleum] Association took a different approach. They adopted the period of well operation between repairs as the basic evaluation indicator for the work of the repair workers. The idea was simple: if the repair workers do better work, the wells will operate longer between repair jobs.

The results were not long in showing. The period of well operation between repair jobs in the Bashkirskaya ASSR rose by an average of 50 days and the coefficient of well operation reached 0.96. This experiment was approved by the collegium of the Ministry of Petroleum Industry and recommended for introduction at all oil fields in the country.

The system for evaluating the labor of oil prospectors has undergone major changes recently. The drilling workers of Tatneft' [Tatarskaya ASSR Petroleum] Association initiated these changes by substituting "newly created capacity" in place of "meter of drilling" as the chief criterion of drilling work. The abstract meter measurement was replaced by a system of evaluation according to the final result, the extraction of oil from the new wells.

The initiative of drilling foreman D. Nurutdinov of Al'met'yevsk was very important. He published a proposal in SOTSIALISTICHESKAYA INDUSTRIYA suggesting that competition be started among prospectors and their related workers under the slogan "Put oil wells into flow production!" Participants in this competition have done a great deal toward practical development of a new system of planning and material incentive for drilling work. Its effectiveness can be judged by the following figure. In one year roughly 100,000 tons of additional oil was recovered in the Tatarskaya ASSR alone by accelerating the launching of new extraction capacities.

Taking steps to refine the economic mechanism occasionally forces us to look with different eyes at customary things and practices. For example, take the universal indicator of labor productivity. In the oil industry it would appear to be completely clear and simple: the volume of "net" output, that is oil extracted, is divided by the number of persons working. But how well does this reflect the actual situation?

Take two oil deposits. One is new, recently launched, while the other is old, in the final stage of exploitation. At the first each well produces, say, 300 tons of oil a day, while output per well at the second is 20-30 tons. Of course, the collective working at the new field will

come out way ahead in labor productivity, even if they keep a large number of operations personnel for each well.

This was not the only paradox encountered by the central sectorial commission, formed in the ministry, on refinement of planning and increasing the effectiveness of the economic mechanism. In this particular case it was decided to make specific labor inputs per well the chief criterion of the work efficiency of oil extraction enterprises. This indicator will not only reflect the actual situation more objectively, but also will direct collectives to save labor by every means and accelerate the pace of scientific-technical progress.

The necessity of refining the economic mechanism in the petroleum industry can also be seen graphically in the case of the important national economic challenge of improving the use of natural resources by increasing the oil yield from the pools. We have encountered substantial difficulties in solving this problem.

One of the chief obstacles, however, related to questions of evaluating the economic efficiency of this work, not to technical matters. Because new techniques of increasing oil yield require more complex technology and additional expenditures for the purchase of chemicals and production of steam, hot water, and the like, the economic effect of their application was evaluated as negative. The most vigorous administrative steps and directives had difficulty surmounting this factor. Scientists had no interest in developing "unprofitable" plans, and for production workers the campaign to increase oil yield brought lower profit, which also reduced incentive funds.

A radical alteration was needed in the action of the levers of the economic mechanism. Enterprises had to be given an interest in the use of new techniques. The following solution was found. The ministry set up a centralized fund to finance work on increasing oil yield. Increased expenditures in the initial stage of introducing new processes are now financed from this fund, which prevents a worsening of the economic indicators of associations and oil extraction administrations.

In our opinion, however, the potential of this form of financing is not being used fully enough. It would be wise to broaden the area of application of the centralized fund, directing part of the capital to material stimulation of work done in the related sectors of machine building, instrument making, and the chemical industry. This step will help unite the efforts of all the organizations working on this problem regardless of their departmental affiliation.

In recent months USSR Gosplan and other central departments and committees have released a series of methodological materials on various questions of the work of industrial enterprises under the new conditions.

The appearance of these normative documents can only be welcomed. Unfortunately, however, they take no account whatsoever of the specific features of the extracting sectors. In order to adapt a particular methodology to our conditions it usually must be tailored from, as they say, start to finish, and then consent to all the changes must be gotten.

It would seem better to formulate these documents in more general form, allowing the ministries themselves to determine their concrete features. Another variation is also possible. The methodologies may be quite detailed, but then they must contain points that reflect the distinctive characteristics of the extracting sectors. Otherwise, there will be duplication of work, consuming a great deal of time and effort for various types of refinements and consent-gathering.

The sectors are now working hard to develop the plan for 1981 and the 11th Five-Year Plan as a whole. It is extremely important here that the plan be based on rigorous engineering calculations, as demanded by the July 1979 decree of the CPSU Central Committee and USSR Council of Ministers. But there are cases where the corresponding divisions of USSR Gosplan do not take our calculations into account, but continue to rely on so-called expert evaluations. This may lead to imbalance in a number of sections of the plan.

The limitations of a newspaper article prevent me from doing more than touching on certain questions of improving planning and raising the efficiency of the economic mechanism in the petroleum industry. The comprehensive economic program ratified by the collegium of the Ministry of Petroleum Industry also contains other major steps. In particular, it envisions an improvement in planning on the basis of technological plans for exploitation of deposits and enterprise "passports" and the introduction of a system of automated planning calculations.

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SOYUZGLAVNEFT' SUPPLY DISTRIBUTION PLANNING IMPROVED

Moscow EKONOMIKA I MATEMATICHESKIYE METODY in Russian No 3, May-Jun 80 pp 491-501

[Article by O. D. Protsenko et al: "Automated Set of Soyuzglavneft' Planning Computations (Results of Elaboration and Adoption)"]

[Text] Work has been in progress since 1975 on improving planning of supply of refined petroleum products to the national economy on the basis of economic-mathematical methods and computer hardware, conducted jointly by NIIMS [expansion unknown] and the Main Computer Center of USSR Gossnab [State Committee for Material and Technical Supply], with the direct participation of Soyuzglavneft'. A set of automated computations (KAR) is being developed, consisting of three interlinked problems which are at various stages of adoption: forming of industry orders (FZP), forming of union balances and distribution plans (FPR), and forming of union republic balances and plans, with inclusion of interrepublic supply volumes (FMP). At the present time the FZP problem has been submitted for industrial utilization.[1] The FPR is in the process of experimental testing of algorithms, while economic-mathematical models and methods are being worked up for the FMP.

In this article we shall examine the principal results of elaboration and adoption of KAR; designing methodology is discussed in the example of the second (central) problem of the set, since FZP is a particular case, while FMP constitutes further synthesis of FPR.

Computer conversion of the second problem is performed on the basis of specific principles of combining new and traditional methods of processing planning information, taking into account existing standard design solutions, principles which have been verified in the course of elaboration and adoption of the first problem [1]. These principles, which are examined below in greater detail, make it possible to overcome difficulties of adoption which are caused by nonsimultaneity and a differing degree of work-up of interrelated problems; special procedures of linking computer and expert solution elements are utilized, and simulation computations for accelerated working-up of algorithms [2].

Description and Procedure of Solving the Problem of Forming Refined Petroleum Products Union Balances and Distribution Plans

The FPR problem comprises an aggregate of forecasting calculations performed on the basis of a computer in the second and third quarters of the year preceding the plan-covered year, for the purpose of determining requirements and assets. Large volumes, tight timetables, a lack of uniform methods and imperfection of data processing techniques lead in many instances to substantial errors in striking a balance in distribution (both to the side of short supply and oversupply). The principal defects of the established scheme of decision-making involve errors in determining requirements, which are established by main administration commodity divisions in the process of defense by holders of stocks of requests for refined products and are recorded on an annual basis by supply plan reconciliation documents (the sum of the "allocated funds" and "remaining disagreements" columns). In most cases these discrepancies coincide with differences between stated requirements and allocated funds, which directly indicate the insufficient effectiveness of the procedure of review of aplications. Often the requirements specified by holders of stocks prove to be overstated. There exist substantial shortcomings in the "mechanism" of distribution, especially as regards priority of determination of funds for short-supply refined products.

The procedure of solving the FPR problem proposed by us contains three stages.

1. Preparation of a file of data containing input information occurs as so-called base dynamic series and forecasting error series. For each of 13 indices for 60 holders of stocks and 200 refined products there is a base series and two (conjugate) dynamic error series. File volume is several megabytes.[2]

2. Element forecasting of supply indices is performed on the basis of file information. Dynamic consumption and production series are continued with the aid of a computer, broken down by balance items by holders of stocks, republics and the country as a whole. One determines the values of requirements, supply, revenues, carry-overs, non-balances and corresponding forecasting errors. Computer forecasts of base indices are forwarded for expert examination to the main administration, after which they are fed into the computer, which establishes final (computer-expert -- resultant) forecasts for all specified indices in the form of upper, lower and average estimates of their values.

3. Balance-sheet coordination of element forecasts is performed on the basis of a prior elaborated economic-mathematical forecast balance model which is extensively utilized with FZP [3]. The results -- upper and lower estimates of requirements and funds -- are normalized so that summary values of supply indices of holders of stocks coincide with the forecasts of the corresponding indices taken for the national economy as a whole.

Normalized estimates of requirements and funds limit the area of uncertainty of solution and constitute distribution input data; the process of distribution is implemented with the aid of a special algorithm, which will be examined below.

KAR Methods and Algorithms Elaborated in Development of Standard Design Solutions

A system of refined products forecast balance models forms the basis of the methodology.

We shall designate with V_j^{t} synthesized forecast of requirements -- requisite stocks received of refined products to the supply depots and warehouses of the republic Neftesnabsbyt (holder of stocks) j

$$V_j^{\text{t}}=(1+k_j)(V_j+g_j^1+g_j^2+g_j^3)-R_j^{\text{n}},$$

where k_j -- forecast of unit stocks-coefficients of "standardization" of refined products carry-overs with the suppliers,[3] equal to $k_{ij}=k_{ij}^{*}$ for year i -- with availability of an expert estimate, and $k_{ij}=k_{ij}^{H}\leq k_{i-1,\,j}$ -- otherwise; V_j -- anticipated production-operational requirements (PEN); g_j^1, g_j^2, g_j^3 -- anticipated supplies for export, for other republics, and other, respectively; R_j^{H} -- anticipated carry-overs with suppliers at beginning of year i $R_{ij}^{\text{n}}=\max(R_{ij}^{\text{n}*},R_{i-1,j}^{\text{o}})$, whereby $R_{ij}^{H*}=R_{i-1,j}^{H}+Q_{i-1,j}^{\text{t}}-G_{i-1,j}^{\text{t}}$, $R_{i-1,j}^{\text{o}}$ -- account-reported supplier carry-overs at beginning of year preceding plan-covered year; $Q_{i-1,j}^{\text{t}}$, $G_{i-1,j}^{\text{t}}$ -- plan-specified indices of synthesized stocks received of refined products to depots and warehouses of holder of stocks j and synthesized refined products supply to corresponding purchasers in that same year; anticipated carry-overs at year's end i-1

$$R_{i-1,j}^{\text{o}}=k_{i-1,j}G_{i-1,j}^{\text{t}}$$

We shall introduce an indicator of maximally possible stocks received to holder of stocks depots and warehouses j: $W_{ij}^{\text{t}}=W_{ij}^{*}$ with expert estimate;

$W_{ij}^{\text{t}}=W_{ij}^{*}\geq W_{i-1,j}$ -- otherwise, and we shall determine a synthesized forecast of stocks received -- anticipated refined products supply to depots and warehouses of holder of stocks, j, in the form

$$Q_j^{\text{t}}=\begin{cases} V_j^{\text{t}}, & \text{if } V_j^{\text{t}}\leq W_j^{\text{t}},\\ W_j^{\text{t}}, & \text{if } V_j^{\text{t}}>W_j^{\text{t}},\\ 0, & \text{if } V_j^{\text{t}}<0,\end{cases}$$

$Q_j^{\text{t}}=Q_j+q_j^1+q_j^2+q_j^3$, where Q_j -- forecast of own production; q_j^1, q_j^2, q_j^3 -- anticipated received products from import, from other republics, and other, respectively. In like manner

$$G_j^{\text{t}}=G_j+g_j^1+g_j^2+g_j^3.$$

where G_j -- anticipated stocks -- preliminary forecast of own deliveries of refined products to customers for PEN

$$G_j = V_j - d_j,$$

where d_j -- anticipated shortage.

In conclusion we shall note that

$$d_i = \max(0, d_i^*), \qquad (1)$$

where

$$d_i^* = V_i^1 - Q_i^1. \qquad (2)$$

Table 1. Values of Computer, Expert and Computer-Expert Forecasts of Economy's Requirements in One of Refined Petroleum Products for Period 1973-1978, tons*

Источник данных 1		Годы 2					
		1973	1974	1975	1976	1977	1978
База 3		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Прогноз 4	машинный 5	–	2283	2270	1632	1406	1724
	экспертный 6	3384	2677	2312	1275	2629	2100
	машинно-экспертный 7	–	2273	2268	1240	1436	1760

Key:

1. Source of figures
2. Years
3. Base
4. Forecast
5. Computer
6. Expert
7. Computer-expert

* In some cases the indices of resultant (computer-expert) forecasts may be less (greater) than corresponding computer and expert forecasts if both were overstated (understated) in the past. This occurs because the examined method effects a correction by forecasting errors of forecasting. For example, in calculating 1976 requirements (see fourth elements of dynamic series), computer forecasting error was -430, and expert forecasting error -580; upper and lower computer forecasting estimates were 1632 and 1202 respectively; upper and lower expert forecast estimates: 1275 and 695; upper, lower and average computer-expert forecasting estimates are 1480, 1000 and 1240 respectively.

Realization of the model begins with determination of element forecasts

$$V_i,\ W_i^s,\ k_i,\ Q_i,\ q_i^1,\ q_i^2,\ q_i^3,\ \varepsilon_i^1,\ \varepsilon_i^2,\ \varepsilon_i^3.$$

Forecasting is performed on the basis of methodology of adaptive continuation of dynamic series, which includes a modified method of the moving average [4] and method of forming compromise solutions, which is examined

below. Element forecasting is performed twice: at the computer center, which produces computer forecasts, and at the main administration, where they are subjected to expert examination. Introduction of expert estimates (forecasts) into KAR substantially increased the reliability of end results, thanks to the ability of the expert to perform informal multiple-factor analysis of supply prospects with prediction of process "discontinuities."[4] The danger of distortion of forecasts as a consequence of the influence of the subjective, market and other factors accompanying informal (human) solution elements is reduced to a minumum due to objectivization of computer-base final data. An algorithm[5] linking computer and expert solution elements on the basis of retrospective analysis and extrapolation of forecasting errors has been elaborated and realized. It has been established by mass computations that on the average final computer-expert forecasts (for illustration see Table 1) are more accurate than computer or expert forecasts alone.

Computations of element forecasts are preceded by forming of base dynamic consumption and production series broken down by balance-sheet items for holders of stocks and the national economy as a whole. This important and complex job is performed on a computer on the basis of special algorithms, the effectiveness of which is not inferior and in some instances is superior to the effectiveness of any other KAR procedures. This applies particularly to the following input data correction algorithm when forming base requirements series for PEN[6]

$$V_{ij}=\begin{cases} \min\limits_{(i^{\circ},j^{\circ})} (V_{ij}^{\circ}, G_{ij}^{\circ}, G_{ij}), & \text{if } k_{ij}G_i^{t} \leq R_{ij}^{*}, \\ \max\limits_{(i^{\circ},j^{\circ})} (V_{ij}^{\circ}, G_{ij}^{\circ}, G_{ij}), & \text{if } k_{ij}G_i^{t} > R_{ij}^{*}, \end{cases} \tag{3}$$

where V_{ij}, $V_{ij}*$ -- corrected and stated requirements for PEN; G_{ij}, G_{ij}^{*} -- report and plan-specified supply for PEN; k_{ij} -- element of base series of unit stocks; G_{ij}^{t} -- report supply for PEN, export, other holders of stocks, etc; R_{ij}^{k} -- report carry-overs of suppliers at year's end; I -- set of years in plan-covered period, $i \in I$; Y -- set of indexes of holders of stocks, $j \in Y$ (for the national economy as a hole, j=0).

Table 2 contains an example of forming a base dynamic requirements series for PEN.

Base series of maximum stocks received (for an illustration see Table 3) are determined on the basis of report, plan and forecast values of own production, import, stocks received from other holders of stocks, and other stocks received, taking into account refined product shortage situation.

The base elements of dynamic series of unit stocks are formed directly of plan-specified supplier carry-overs at year's end and plan-specified supply deliveries for PEN, export, to other holders of stocks, etc[7]

$$k_{ij}=R_{ij}^{*}/G_{ij}^{t*}.$$

Table 2. **Forming of Base Series of National Economy Requirements in One Refined Product, tons**

	Показатели (1)	Годы (2) 1973	1974	1975	1976	1977	1978
3	Остатки на конец года						
4	условно-необходимые	219	56	65	56	323	293
5	отчетные	2426	1307	663	1014	1005	1089
6	Поставка на ПЭН						
7	плановая	3384	2677	2312	1275	1811	1535
5	отчетная	2273	2269	1632	1405	1935	1798
8	Потребность на ПЭН						
9	заявленная	3384	2677	2312	1275	2269	2100
10	базовая (откорректированная)	2273	2269	1632	1275	1811	1535

Key:

1. Indices
2. Year
3. Carry-overs at year's end
4. Conventional-essential
5. Report
6. Supply for PEN
7. Plan-specified
8. Requirements for PEN
9. Declared
10. Base (corrected)

Table 3. **Forming of Base Series of Maximum Stocks Received of One Refined Product for the National Economy as a Whole,* tons**

	Показатели (1)	Годы (2) 1973	1974	1975	1976	1977	1978
3	Дефицит	0	0	0	0	0	0
4	Собственное производство						
5	отчет	2877	1877	1495	2157	2093	2184
6	план	2797	1800	1500	2000	2200	2200
7	прогноз	–	2380	1856	2151	2356	2447
8	Прочие поступления						
5	отчет	118	140	0	0	263	0
6	план	118	0	14	0	263	0
7	прогноз	118	0	0	0	324	0
9	Максимальные поступления (база)	2995	2017	1514	2157	2463	2200

Key:

1. Indices
2. Years
3. Shortage
4. Own production
5. Report
6. Plan
7. Forecast
8. Other stocks received
9. Maximum stocks received (base)

* For import and stocks received from other holders of stocks all report, plan and forecast indices are zero.

Table 4. Forming of Base Series of Non-Balances for One Refined Product, tons

	1 Показатели	2 Годы					
		1973	1974	1975	1976	1977	1978
3	Обобщенные поступления	2877	1877	1495	2157	2093	2184
4	Обобщенные поставки	2737	2824	2153	1809	2365	2092
5	Остатки у поставщиков						
6	на начало года	2168	2426	1307	863	1014	1005
7	на конец года	2426	1307	863	1014	1005	1097
8	Небалансы	−118	−140	214	137	−263	0

Key:

1. Indices
2. Years
3. Synthesized stocks received
4. Synthesized supply deliveries
5. Carry-overs with suppliers
6. At beginning of year
7. At year's end
8. Non-balances

Base elements of own production Q_{ij}, import q_{ij}^{1}, received stocks from other holders of stocks q_{ij}^{2}, export g_{ij}^{1}, and deliveries to other holders of stocks g_{ij}^{2} are identified by the values of the corresponding report indices.

The base elements of other received stocks and supply deliveries are calculated from report figures on resources and distribution $\delta_{ij}=|\Delta_{ij}|$, and Δ_{ij} -- discrepancy between summary values of report indices in balance resource and distribution items (henceforth non-balance) is determined by

$$\Delta_{ij}=Q_{ij}^{\Sigma}+R_{ij}^{н}-G_{ij}^{\Sigma}-R_{ij}^{к}.$$

In the absence of report (execution) balances, values Δ_{ij} compensate for information distortions which can occur as a consequence of unverified substitutions of refined products, due to errors of multiple coversion of input information during consolidation and transmission to higher agencies, as well as for other reasons. Forecasting of non-balances ensured not less than 10 percent effectiveness of adoption of the FZP problem. Table 4 contains an example of forming of a base series of non-balances.

Method of Compromise Solutions

Realization of the system of all formulated relations ensures determination of upper and lower estimates of anticipated requirements and supply deliveries for PEN (preliminary stock forecasts), which limit the region of indeterminacy of solution of FPR problem

$$\begin{cases} SZ_i=\max(Z_i, Z_i+\Delta Z_i), \\ IZ_i=\min(Z_i, Z_i+\Delta Z_i), \end{cases} \qquad (4)$$

SZ_j, IZ_j -- upper and lower estimates of anticipated requirements (or stocks),[8] Z_j, ΔZ_j -- values of computer-expert forecasts and forecasts of requirements (or stocks) forecasting errors. Both requirements and stocks are not coordinated

$$(SZ_0 \neq \sum_{j\neq 0} SZ_j,\ IZ_0 \neq \sum_{j\neq 0} IZ_j).$$

Coordination (normalization) of upper (or lower) estimates of anticipated requirements (or stocks) is performed[9] with (5) for $\pi(Z_0)=0$ and, in conformity with (6), for $\pi(Z_0)=1$

$$\bar{Z}_j = \begin{cases} Z_j - \left(Z_0 - \sum_{j\neq 0} Z_j\right) \dfrac{\Delta Z_j}{\sum_j \Delta Z_j} & \text{when } Z_j = Z_0, \\ Z_j + \left(Z_0 - \sum_{j\neq 0} Z_j\right) \dfrac{\Delta Z_j}{\sum_j \Delta Z_j} & \text{when } Z_j \neq Z_0, \\ Z_j, & \text{when } Z_j = Z_{j'}, \end{cases} \tag{5}$$

$$\bar{Z}_j = \begin{cases} Z_j + \left(Z_0 - \sum_{j\neq 0} Z_j\right) \dfrac{\Delta Z_j}{\sum_{j\neq 0} \Delta Z_j} & \text{when } Z_j \neq Z_0, \\ Z_0, & \text{when } Z_j = Z_0. \end{cases} \tag{6}$$

Here $\pi(Z_j)$ is an index of preferences, $\pi(Z_j)=1$, if the final forecast is made equivalent to preliminary forecasts, and $\pi(Z_j)=0$ if otherwise; $\bar{Z}_j$, Z_j -- new (coordinated) and old (uncoordinated) values of anticipated requirements or stocks; ΔZ_j -- anticipated forecasting errors -- differences between upper and lower estimates of anticipated requirements (or stocks);

$j \in Y = \bar{Y} \cup Y' = \{0, 1, \ldots\}$ -- indexes of holders of stocks; $\bar{Y} = \{j\}$, $Y' = \{j'\}$ -- serial numbers of indices for which $\pi(Z_j)=0$, or $\pi(Z_j)=1$ respectively. See Table 5 for an illustration.

Table 5. Values of Forecast Indices by Holders of Stocks (for 1979), tons

1 Индекс фондодержателя	2 Ненормализованные				3 Нормализованные			
	SV_j	IV_j	SG_j	IG_j	$S\bar{V}_j$	$I\bar{V}_j$	$S\bar{G}_j$	$I\bar{G}_j$
0	2551	2176	2551	1632	2551	2176	2551	1632
1	1569	1539	1300	775	1592	1431	1543	986
2	434	411	355	119	451	328	464	214
3	495	478	495	389	508	417	544	432

Key:

1. Index of holder of stocks
2. Non-normalized
3. Normalized

Figuring Errors of Forecasting Requirements and Supply Deliveries -- Basis of Distribution of Refined Petroleum Products

In the FPR problem one takes systematic account of errors,[10] which made it possible to increase reliability of calculations and to refine the procedure of distribution.

We shall note the following circumstances, connected with automated error analysis:

in the course of element continuation of base series, computer forecasts are corrected taking forecasting errors into account; an effective correction procedure, a component of a modified method of moving average, has been elaborated [4];

linking of computer with expert forecasts is performed by the method of forming compromise solutions (5), (6), based on taking forecasting errors into account;

forming of forecast balances is effected with upper and lower estimates of anticipated consumption and production indices, determined taking errors into account (4); forecasts of holders of stocks are normalized with the aid of (5), (6) and results of analysis of forecasting errors.

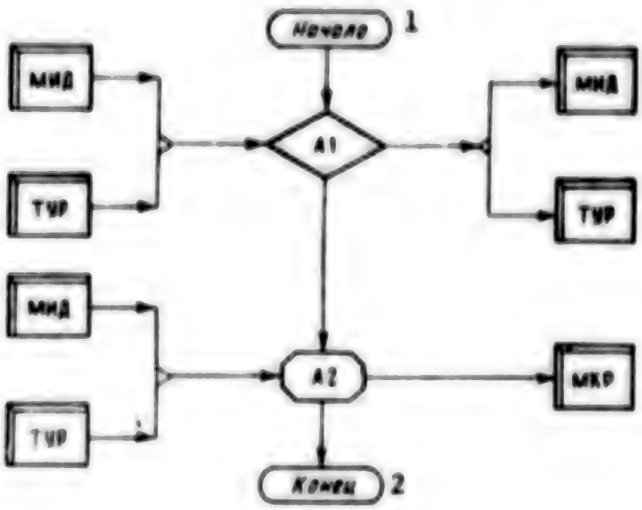

Figure 1. (МИД -- Input Data File, ТУР -- Solution Control Table, МКР -- Final Result File)

Key:
1. Start
2. Finish

Let us examine the procedure of forecasting stocks (Figure 1). Input data are upper and lower estimates of anticipated requirements and supply deliveries for PEN broken down by holder of stocks, obtained in the process of calculation of forecast refined products balances. It was previously noted that these estimates limit the region of indeterminacy of problem solution

$$IV_j \leq V_j \leq SV_j,\ \ IG_j \leq G_j \leq SG_j,\ \ j \in Y = (1, \ldots, j^*),$$

within the limits of which the special stocks forming search procedure is subsequently implemented. Estimates of anticipated supply deliveries for PEN are computed by means of procedure[11]

$$SG_j = SV_j - IV_j^a + SQ_j^a,\ \ IG_j = IV_j - SV_j^a + IQ_j^a,\ \ j \in Y,$$

which expands the zone of solution indeterminacy for amplifying the search effect.

The special procedure makes it possible to determine calculated constants:

$$R = \sum_{j \in \theta} (SG_j - IG_j),\ d = \sum_{j \in \theta} (IV_j - SG_j),\ j \in Y, \tag{7}$$

where R -- calculated reserve; d -- calculated shortage. One simultaneously determines values of logical variable

$$L = \begin{cases} 1, & \text{if } d > 0, \\ 0, & \text{if } d \leq 0, \end{cases}$$

for branching of subsequent computations in relation to refined product shortage.

One further realizes two stocks forecasting modifications. When L=0

$$IG_j = IV_j,\ \ IV_j = SV_j,\ \ j \in Y,$$

after which calculated reserve according to (7) is refined.

Then one calculates and puts into the final results file (MKR) final stocks forecasts

$$G_j = IG_j + R\frac{IV_j - IG_j}{\Sigma(IV_j - IG_j)},\ \ j \in Y. \tag{8}$$

If $\bar{L}$=1, then

$$k_R d - R < 0, \tag{9}$$

where $0 \leq k_R \leq 1$ -- reserve factor.

In executing (9), reserves are refined

$$R = |k_R d - R|,\ \ R = k_R d + \bar{R},$$

where R, $\bar{R}$ -- calculated and undistributed reserves.

One then checks conditions

$$IV_j < IG_j,\ \ j \in Y. \tag{10}$$

Here two cases are possible, where inequality (10): 1) is incorrect for any $j \in Y$; then stocks are refined (8) and the results placed in the MKR; 2) is executed for certain $j \in Y^* \subset Y$; in this situation calculated reserve is corrected

$$R = R + R', \quad R' = \sum_j |V_j - G_j|, \quad j \in Y^*,$$

and stocks are refined: $G_j = IV_j$ if $j \in Y^*$; otherwise (8) is utilized. The results are entered in the MKR. If (9) is not satisfied, undistributed reserve is corrected

$$\bar{\bar{R}} = \bar{\bar{R}} + R$$

and the following values go into the MKR:

$$G_j = IG_j, \quad j \in Y. \qquad (11)$$

Mass computations have established that procedure (7)-(11) is advantageously distinguished by the property of eliminating artificial shortages and on this basis covering true shortages, which is equivalent to automated correction of the priority "mechanism" established at the main administration.

Economic-Mathematical Model of Forecasting Interrepublic Supply Deliveries

Interrepublic supply deliveries (outhauling-inhauling) are computed with the formula

$$g_{iJk} = G^{\Sigma}_{iIk} s^{1}_{iJk} + \left(Q^{\Sigma}_{YJk} - \sum_i G^{\Sigma}_{iIk} s^{1}_{iJk} \right) s^{2}_{iJk},$$

where g^{Σ}_{iIk} -- sought volumes of intra- and interrepublic deliveries by supplier i to customer j in period k; G^{Σ}_{iIk} -- specified (by the solution of problem FPR) values of synthesized deliveries by republic-supplier i; $s_{ijk} = g_{ijk}/G^{\Sigma}_{iIk}$ -- supply delivery structure elements determined by the method of adaptive continuation of dynamic series; Q^{Σ}_{Yjk} -- specified (by solution of problem FPR) values of synthesized received stocks by republic-recipient j;

$s^{2}_{iJk} = q_{iJk}/Q^{\Sigma}_{YJk}$ -- received stocks structure elements determined by the method of adaptive continuation of dynamic series.

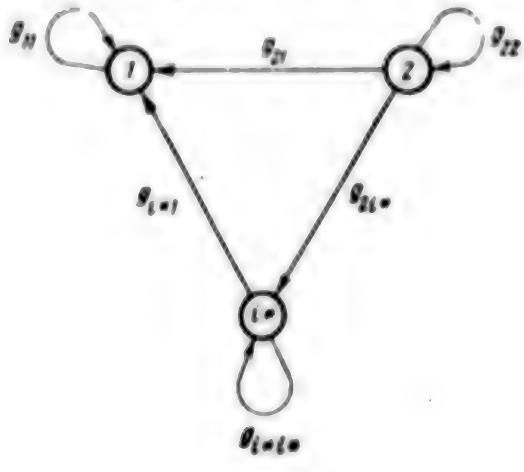

Figure 2.

Outhaul-inhaul volumes can be presented in tabular form or in intra- and inter-republic supply deliveries represented on a graph (Figure 2).

Principle of Insertion of Problems. Effectiveness of KAR

Elaboration of KAR is performed in such a manner that the first problem is a part of the second, while the second in turn is a part of the third. This method of design, which could be called the principle of problem insertion, is considered by us to be a basic principle since, in the first place, subsequent problems are constructed on a real information, methodological and program base and, secondly, preconditions are created for improving (final-adjusting) models, algorithms and programs in problems elaborated later, whereby the process of incorporation does not stop. The greater part of the economic effectiveness of KAR is realized at the early stages. Improved models are gradually supplanting the initially adopted models (comparison of the algorithms of the FPR and FZP problems [2, 3] indicates that the former has a relatively higher level).

At the present time FZP has been put into commercial operation in spite of certain defects, which will be corrected during adoption of FPR.

Third, the principle of insertion ensures methodological unity of KAR, based on a system of economic-mathematical models and algorithms of refined petroleum products forecast balance.

Implemented in elaboration and adoption of KAR is an approach from forecasting requirements and forming industry's supply orders to forecasting distributions and forming proposals for interrepublic refined products supply deliveries. Three or four years ago such extensive forecasting method possibilities were in the realm of assumption. Now they have been realized to a significant degree. Today one can state the problem of computer-base computation, at the beginning of any year preceding the plan-covered year, of balances of distribution and inter-republic supply deliveries as a component of preliminary draft supply plans — information sources for prompt decision-making on efficient distribution of production, consumption and stocks, as well as on optimization of transport flows of refined products.

The economic effectiveness of the set is due to greater balance reliability and is due to the improved procedure of distribution of refined products. It is presently estimated at 3-4 million rubles per year.

Anticipated (calculated) and actual effectiveness are differentiated.

The former is determined in several stages. Initially preliminary effectiveness is calculated on the basis of playback of supply retrospective; preliminary effectiveness is subsequently refined in the course of KAR incorporation (realization).

We shall call effectiveness elucidated on the basis of problem realization realized effectiveness. It is usually determined on the basis of incomplete product composition[12] and constitutes the basis for refinement of anticipated effectiveness with involvement in the analysis of so-called calculated savings and calculated outlays on the full refined petroleum product list.

Actual effectiveness is determined from actual savings and actual outlays occurring in the course of KAR elaboration and adoption.

At the present time realized and refined calculated effectiveness have been determined for the FZP problem, comprising 800,000 rubles per year and 2.0-2.5 million rubles per year respectively. Anticipated effectiveness of the FPR problem is estimated at not less than 600-700 thousand rubles per year.

FOOTNOTES

1. Encompassing the entire list of refined petroleum products (200 product designations). L. S. Yakovlev, Ye. G. Torchinskiy, M. M. Imyanitov, and V. I. Smelyanskiy (USSR Gossnab Main Computer Center) took part in elaboration and adoption of the FZP problem.

2. The file contains retrospective information on the following supply indices: requirements for production-operation needs (PEN) for holders of stocks and the national economy as a whole, supply delivery for PEN (same breakdown), for export by union republics and the entire national economy, to other union republics, broken down by republic, production in union republics and for the national economy as a whole; received stocks from import (same breakdown), from other union republics by holders of stocks, maximum received stocks by holders of stocks and the national economy as a whole; supplier carryovers at beginning of year (same indices), and separately for year's end; unit stocks -- coefdicients of standardization of carryovers, shortages and non-balances (same breakdown).

3. At refineries, en route, and at republic neftesnabsbyts.

4. Maximum forecasting errors were reduced in the final total.

5. It is a component part of the method of forming compromise solutions.

6. It represents 20-30 percent of economic effect achieved with adoption of the FZP problem, that is, not less than 150-200 thousand rubles per year.

7. The values $R_{ij}^{r*}, G_{ij}^{\Sigma*}, i \in I, j \in Y$ are borrowed from plan specified refined product balances.

8. Here and henceforth the letters S, I apply to upper and lower estimates respectively of anticipated values of supply indices.

9. Also secured on this basis is linking of computer and expert forecasts, with preference given, in general terms, to expert forecasts for export, import, maximum received stocks and unit stocks. Relation (6) is also utilized for introducing changes.

10. In contrast to the FZP problem, where errors were only partially taken into account (for example, in linking computer forecasts with the expert method of least squares [3]), whereby taking into account was sporadic and implicit.

11. In contrast to requirements, which are determined directly with formula (4).

12. Only that part of the solution which has been adopted and practically utilized by the main administration is considered.

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Received 5 March 1979

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CSO: 1822

EXPLOITATION OF ASSOCIATED GAS IN SAMOTLOR, TYUMEN' REPORTED

Moscow PRAVDA in Russian 17 Jun 80 p 1

[Article by V. Lisin, PRAVDA Correspondent, Nizhnevartovsk, Tyumenskaya Oblast: "The Flames on Oil Fields Are Going Out: Construction Projects Should Be Completed!"]

> [Text] "The losses of gas associated with petroleum should be markedly reduced and for 1980 the use of gas on the scale of 43-45 billion cu m should be assured. The construction of gas refineries should be accelerated." [From "Basic Directions of Development of the USSR Economy for 1976-1980."]

The gas flames burning on oilfields look from afar like exotic flowers, but on closer approach they resemble a roaring whirlwind. The exotic spectacle makes no one happy: the [thus wasted] associated gas could have been used to produce gasoline, polyethylene, synthetic rubber, tars, and fuel. That is why a gas refinery began to be built in 1970 in Nizhnevartovsk near the renowned Samotlor Oilfield.

Soon the refinery began operating--producing dry gas and the so-called broad fraction or unstable gasoline. By now millions of cubic meters of the "blue fuel" are being dispatched daily from Nizhnevartovsk via the Trans-Siberian Gas Pipeline to Surgut and Kuzbass. As for the benzine, it proceeds by rail to the nation's petrochemical enterprises.

The capital of Samotlor has become a major center for processing associated gas. Four technological sections, each essentially representing a complete plant on its own, already operate in the same area here. They can process 8 billion cu m of the valuable raw material. This is the most impressive facility yet to be operated by the nation's petroleum industry.

At present the level of utilization of associated gas at the Samotlor Oilfield reaches 70 percent and is rising. Soon now the largest refinery, the Belozernyy, with a capacity of 4 billion cu m of gas annually, will be opened.

...The concrete truck carried us farther and farther from Nizhnevartovsk. Somewhere near the 70th kilometer the Volga [truck] climbed a hill from which unfolded to the eye a festal silvery vista of the Belozernyy Gas Refinery framed in the emerald green of the taiga.

Together with Ye. Antropov, Chief Engineer of the Megiongazstroy Trust, I toured the enterprise.

Antropov said: "Like all other plants we built in Nizhnevartovskiy Rayon, this plant is modernly equipped and employs an efficient gas processing technology."

The Megiongazstroy Trust is one of the oldest in Nizhnevartovsk and one of the best construction trusts under the Ministry of the Construction of Petroleum and Gas Industry Enterprises. It builds gas refineries ahead of schedule and transmits them, as a rule, with an "Excellent" evaluation.

What is the secret of its success? The militancy and solidarity of the trust's personnel. As noted by the party committee secretary V. D. Pilyusov, there are no laggard brigades in that trust, even though the average age of their members is 25 years. Consider for example the brigade of Vyacheslav Yankeyev. Several years ago, demobilized border guards were assigned to the trust. They decided to work together in a single brigade. Now each of them has mastered 2 or 3 skills, and together they compete as equal rivals of the more experienced collectives.

Owing to such a fusion of youth and experience, the trust is coping with advanced working techniques and is widely based on the brigade system.

The stability of its personnel could be envied by enterprises operating under more favorable climatic conditions. It is not just their earnings that keep these people in their jobs--they also are drawn by the concern shown here for their needs. At the party municipal party committee I was told that the trust has completely solved such an acute problem of the new cities and settlements in the [Far] North as the availability of kindergartens. I asked Ye. Andropov how this was accomplished.

He answered: "We simply built a kindergarten. That's all."

Simply...., but how often such simplicity is missing among other heads of the rayon who forget that the fulfillment of production targets largely depends on the solution of the problems of living and social conditions. Incidentally, the trust also is solving its housing problems in a better manner than do the other organizations in Nizhnevartovsk.

The trust's personnel perform well. But they themselves say that they could perform still better. What is the problem then? It is the persistent shortages of material and technical resources, especially of structural metal components and finishing materials. The trust is continually short

of heavy-duty soil-loosening equipment, pneumatic-traction cranes, and high-yield excavating machinery. Owing to the absence of light-duty equipment, the volume of manually performed excavating operations is markedly increasing. A culprit is the principal project-design organization--the YNIIgazpererabotka Institute in Krasnodar. The project-estimate documents which it provides do not always consider new achievements of science and technology. For example, the room-unit technique of construction still has not, for some reason, been adopted.

...the Tyumen's gas refiners face a very busy period. New fields are being developed, and petroleum extraction is rising. The program for developing the processing of associated gas as a new branch of industry in Western Siberia is also being fulfilled. Soon the gas refinery in Surgut will start operating. This is to be followed by the construction of similar enterprises near the settlements of Lokosovo, Tarko-Sale, and Krasnoleninsk in the rayon. As early as within the nex five-year plan it will be possible to utilize all the associated gas and put out the gas flames.

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PROGRESS, PROBLEMS IN DEVELOPMENT OF SURGUT OILFIELDS

Moscow SOVETSKAYA ROSSIYA in Russian 16 Apr 80 p 2

[Article by G. Goloshchapov, first secretary of the Surgut City Committee of the CPSU: "On the Cutting Edge of Out Time"]

[Text] To begin the discussion I will cite a few typical figures. The volume of work done in the city of Surgut and in the rayon last year exceeded the work volume for the entire preceding five-year plan. Compared to 1975 petroleum extraction increased 3.2 times, electricity production was up 2.3 times, and the construction of producing wells quadrupled. Each year capital investment in the Surgut industrial region exceeds 1 billion rubles. That is the rate of development of our region today, and it is going to increase steadily. The interests of the country demand it.

The communists of the city party organization are well aware that increasing the scope of settlement in the region will require hard work, great responsibility, and an ability to influence those working with us and to bring all reserves into operation. Under northern conditions it is not at all simple to live and work vigorously. This is probably why some people return to the settled regions. We are in no hurry to condemn these people or accuse them of cowardice. After all, it takes time even to learn about oneself, and it is no surprise that many of those who left the north have come back to us after a while. This must be because the settled regions do not offer them a broad sweep and a sense of personal involvement in a major construction project.

The region finds itself on the cutting edge of our time. Many new machines and new technologies are being tested here. The boldest designs are conceived and carried out. All this forces party workers to face a constant test of maturity and actively influence technical progress. The challenge is made even more difficult by the fact that we have very little time to solve the various problems. This means that no time is left for practicing and working out models of action and interrelationships. We do not even have time to look closely at one another. From

the moment they are formed new subdivisions are expected not only to handle intensive plans successfully but also to be ready during the year to perform double or triple the production program.

In most cases we are successful in this. It seems very recently that the second Surgut Drilling Administration was formed, but it was in this subdivision that the drilling advances which set a record in the sector last year came about. The drilling workers' success was made possible by the cooperation of engineers and workers, a tireless search for efficient forms of labor, and of course, thoughtful indoctrination work.

We have many such collectives.

The work of building up oil fields in Western Siberia has characteristic features. First a drilling site must be filled in in the swamp, the road brought to it, the rig delivered and installed, the well drilled and tested, connected to the gathering system, and so on. The stages of work are performed by many subdivisions of different departments. And each one of them keeps its own records in cubic meters, tons, or hours.

But the workers participating in building up the oil fields are doing a single job and they are united by a single purpose: to produce more oil. This means that all subdivisions should work on a single order, striving to build the wells and launch them as well and quickly as possible. Of course, no one anywhere has ever worked that way in the oil fields. Over the decades other tactics, a different style, and different mutual relations have taken shape. And it is not easy, of course, to retrain a person's thinking. Orders do no good at all in this. Party workers began using persuasion and site meetings were held. The agenda was always the same: cooperation among the different subunits and shaping a new attitude toward the work. The economic lever is a real help in teaching solidarity among collectives; cost accounting relations are now being set up among associated subdivisions.

Nonetheless, departmental lack of coordination still causes great harm to the economy and to indoctrination. The city is growing fast. It now has more than 120,000 people. In 10 years it will triple in size. But a clearly organized city system of services has not yet taken shape in Surgut, and some services are completely lacking. Thus the representatives of more than 20 departments resolve questions of the development of communications and transportation any way they can. As a result offices large and small have grown up like mushrooms after a rain. The industrial zone borders on the residential zone, and multidepartmental domestic service, trade, and public catering facilities have been organized. Enterprises performing similar kinds of services operate without coordination, duplicating one another. As a result, the city is not improving with respect to comfort or order. Incidentally, a single builder was stipulated in the corresponding documents for the city, the USSR Ministry of Petroleum Industry. But so

far the ministry has taken up its duties with great timidity, perhaps even reluctance.

While we transform the region we must take care of what nature has made. Party documents constantly emphasize that the development of new, unsettled regions should be done in a planned manner, making economic use of all natural wealth. Examples from our region demonstrate the importance of this requirement convincingly.

A great deal of forest is cleared to lay down various types of pipelines and power transmission lines and to build up oil fields; first-quality lumber is removed from significant areas. Excellent wood, sometimes including cedar, is occasionally pushed out of the way of the construction site by a bulldozer and left to rot. I cannot think that the appropriate agencies do not know how many pipelines will be laid and where, so they also know how much lumber will be cut. Of course they know. Then why not plan to process the wood in these sections? I am not referring to a few dozen hectares, but rather thousands of hectares of first-quality lumber.

This is one side of the problem; here is another. In the 15 years that the northern part of Tyumenskaya Oblast has been under development not a single department has reforested a single hectare of cutover forest. This includes cedar forests. The position taken by most of the ministries on this matter is surprising. Without the slightest embarrassment the managers of some of them say, "Spend money for reforestation? What else do you need?" We do not need much, just for it to be understood that the money is allocated by the state, not by private parties. And moreover, ruble notes, even of the highest quality, will not bring back the forest. The former construction site must be recultivated, planted, and turned over to a forester.

Everything that has been said about lumber applies also to the Ob' River basin which, as everyone knows, is unique for its stocks of certain extremely valuable fish species.

The November 1979 Plenum of the CPSU Central Committee emphasized that in the current phase of economic development attention must be focused on fundamental improvement in the organization of shipping and refining management of all types of transportation. This is an especially urgent challenge for our region for two reasons. The rate of increase in work here is higher than anywhere else and to maintain it we must have an uninterrupted supply of millions of tons of various types of freight. In addition, Surgut has become the forward post for development of even higher latitudes in the oblast and a major transshipment center. Therefore, we have a good idea of both the strong and weak points of transportation operations, as well as the causes of success or failure, which lie above all in the attitude of the various departments toward their obligations.

Two years ago the USSR Ministry of Railroads formed the Surgut rail section. If we consider that at that time many installations on the road were still under construction, the decision to organize a new collective must be acknowledged as not only daring, but also perceptive from a state viewpoint. The point is that it was necessary when straightening out work in the Surgut center to prepare to operate a railroad which is only now being laid to the unique Urengoy field.

How did such a far-sighted decision work out? There is no denying that many difficulties arose at first. But road specialists and managers on the spot wasted no time with consent-gathering and correspondence; they skillfully and quickly took care of mistakes, got the rail artery working normally, and shaped the collective. The challenge Red Banner of the CPSU Central Committee, USSR Council of Ministers, AUCCTU, and Central Committee of the All-Union Komsomol, which was awarded to the Surgut rail section for its successes last year, testifies that they did their job well.

The officials responsible for waterways took a different approach. As long ago as the 25th CPSU Congress the departmental lack of coordination in the operations of river workers was criticized. But to this day the river fleet of Tyumenskaya Oblast is managed by several ministries. The mistakes pointed out by the congress have not only not been eliminated, they have even been aggravated and become a brake on development of the entire region.

The departmental fleets continue to operate as before, with poor coordination and low productivity. The RSFSR Ministry of the River Fleet has not taken over those jobs which are performed today by the vessels of petroleum workers, construction workers, geologists, and gas workers. The managers of the ministry say that it is not profitable for them to engage in small-scale shipping. Moreover, the necessary cooperation has not even been organized among structural subdivisions of the Ministry of the River Fleet itself. Now here is a paradox! Two steamship lines, the Irtysh and West Siberian, which deliver cargo to the northern part of the oblast, cannot find a common language. One line delivers cargo only as far as Surgut, while the other carries it further. The transshipment from one vessel to another exactly like it plus the delays and additional work are completely unjustified. And although the steamship lines do the largest part of their business on the Ob' itself, their offices are thousands of kilometers away in Omsk and Novosibirsk.

The November Plenum of the CPSU Central Committee pointed out that there are still numerous problems in capital construction. It said that they are aggravated by various mistakes and even cases of flagrant mismanagement. This also applies directly to us. A lumber and wood processing combine was to begin operations in Surgut last year according to plan. Its shops would have supplied assembly components for the output of the

Surgut and Nizhnevartovsk home-building enterprises. The combine was supposed to be built by the USSR ministries of Construction of Petroleum and Gas Industry Enterprises, Power and Electrification, and Industrial Construction. Of the 100 million rubles appropriated for the project, however, 3 million have not been incorporated today. At the same time the need for cabinet goods, builtin furniture, and saw timber is growing extremely fast. Each ministry began building its own docks to take care of the scarcity. The USSR ministries of Construction of Petroleum and Gas Industry Enterprises, Power and Electrification, and Transport Construction, after building their own units, are now looking desperately for ways to get equipment. It seems to me that if the divisions of USSR Gosplan kept closer watch on performance of decisions that have been made and monitored the expenditure of capital, it would be possible to avoid the "headache" of which representatives of various departments are now complaining. I admit that I am deliberately using the economic planning term "nonproduction sector." Here is why. It seems to me that certain central departments consider the construction of projects that fall in this classification to be something secondary and nonobligatory. I am sometimes criticized for not being objective when I say that; other people claim to understand the matter as well as I do. I do not dispute that. But you cannot argue with facts. There is a shortage of housing and people are forced to make do in buildings without amenities and to live under crowded conditions. It is also difficult to place your child in a nursery school or daycare center. In general, many things are lacking: clubs, athletic facilities, dining halls, and clinics.

Lack of amenities, of course, does not create a good attitude. And no matter what we may say, one fundamentally important point cannot be disregarded. Inattention to the nonproduction sector has a noticeable effect on the results of production activity, on the rate of development of the oil and gas industry. That is why I would like to emphasize once again that departmental interests should not eclipse the interests of comprehensive development of the city and of our entire region.

On 14 April a meeting was held at the CPSU Central Committee during which the questions of intensifying capital construction in the oil and gas regions of Western Siberia were reviewed. At the meeting additional steps were worked out to accelerate the economic development of our region. I would like very much to hope that all the ministries and departments will adopt a properly responsible attitude toward performance of the tasks set down by the party Central Committee. The workers of Siberia will not let them down; we will do everything we can to carry out these grandiose plans.

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PRODUCTION PROBLEMS AT MURADKHANLYNEFT'

Baku VYSHKA in Russian 19 Jun 80 p 2

[Article by VYSHKA reporting team of E. Garashev et al: "Lost Tons"]

[Text] The work force of the Muradkhanlyneft' NGDU [Oil and Gas Production Administration] adopted ambitious pledges for the final year of the 10th Five-Year Plan. These pledges call for producing 10,000 tons of fuel above target this year. And the oilfield production work force has a definite possibility of surpassing plan targets. Recently, for example, Well 44 went into production here, with a flow of several hundred tons of crude oil per day, and dozens of other wells are producing "black gold."

In spite of this fact, in the first five months of the year the Muradkhanly producers fell approximately 2,000 tons of crude behind target. They are even further behind target in custody transfer: the transfer shortfall is up to 6,000 tons. Although the production shortfall can be claimed to be caused by the fact that the well major repair and overhaul situation is poor (a number of production wells are currently off-line awaiting repairs) and there has been delay in putting promising Well 77 into production, these factors cannot explain the custody transfer shortfall.

Usually oil and gas production associations put the blame on high fuel consumption for their own needs. But there is no such column in Muradkhanlyneft' reports. It is true that existing regulations specify "natural losses," and rather substantial ones at that -- more than one and a half percent of production. But this allowance was surpassed by Muradkhanly in one stroke. In February of this year the main pipeline burst, resulting in a spill loss of 1,500 tons of crude. Part of the spilled crude was retrieved, but many tens of tons remained on the ground. As we know, it is impossible fully to recover fuel from earthen pits.

Yu. Akhmedov, chief mechanical engineer at NGDU, claimed that the pipeline burst because of the unusually cold winter. But the fact is that the pipeline had initially been wrapped in insulation, and if it had been in a normal condition the accident would not have occurred, as NGDU officials themselves acknowledge.

We toured a fairly extensive stretch of pipeline -- and almost everywhere rusty pipe was visible through torn insulation wrapping. And yet the pipeline came on-stream less than 3 years ago.

All crude oil losses cannot be explained, however, with this one large spill. Two lines burst on the day of our inspection. And although the leaks were corrected fairly quickly, the crude congealed in the line. While it was being "forced through" for a period of seven days (!), all NGDU production was going into earthen pits by wells 13, 5, and 7.

By Well 13 we saw five pits filled with crude oil mixed with formation water. We were told that the capacity of each pit was at least 1,000 tons.

We asked why the crude was not being removed from these pits. One of the difficulties, explained A. Kerimov, NGDU technology division chief, explained to us that one of the difficulties was a shortage of equipment and steam-heating units.

There are only two such units available, and they belong to the Imishlinskiy section of the Shirvanskoye Technological Transport Administration [UTT] in Ali-Bayramly, set up to replace the UTT transferred to Kyursangya. We believe that this transfer was untimely. The section is now in the status of a poor relation: its great distance from base has a telling effect. In addition, the oil workers of Shirvanneft' need these units, and the administration gives first priority to their needs, with lesser priority to transporting the machinery 150 kilometers to Muradkhanly.

The NGDU producing inventory includes low-yield wells 23, 27, 12, and 18, which are called "perelivayushchiye." Pressure at the wellhead is too low to drive crude into the pipeline from these wells. Nor is a bottom-hole pump suitable. Production from these wells should be collected in a lease tank and periodically pumped into the pipeline.

NGDU deputy chief Ch. Saidov assured us that such tanks are being erected by all "perelivayushchiye" wells.

We soon ascertained that this is true in half of all instances at best.

At the first of these low wellhead-pressure stripper wells, a large lease tank indeed stood nearby, but it was completely empty, and there was no connection whatsoever between wellhead and tank. Crude from the well was running into... an earthen pit. The heavily oil-soaked ground around this and adjacent producing wells indicated that the crude easily seeps out of this unsophisticated device and frequently overflows it.

But even tanks which have been connected up are not always properly utilized.

Two new tanks have been built in Garasu, where the pipeline from the new Kalamaddin field connects to the line running to Ali-Bayramly. And

although they have been in operation for not more than a month, black stains at the tanks indicate a substantial leakage of crude.

Gauging of produced crude is also unsatisfactory in this NGDU. Several years ago three gauging and testing units (GZU), which monitor well production, were installed at various locations in the oilfield.

The oilfield production people are no longer utilizing any of these. A. Kerimov explained to us that the GZU located near the above-mentioned Well 13 is not being utilized because the wells in the vicinity are high-flow, and therefore it is inconvenient to gauge and test with a unit of that type. The gauging and testing unit near Well 8 was received by the NGDU in practically unusable condition, while the gauging and testing unit near the oilfield worker community of Mamedly is standing idle because of a lack of replacement parts -- three-way cocks.

Has the Sputnik automatic custody transfer unit, which is being successfully utilized in many of this country's oil-producing regions, had a better time of it?

It seems not. When we drove up to two railcar modules containing an AM-10-40-400 LACT unit, intended for the sequential gauging and testing of flow from nine high-flow wells, it was immediately apparent that nobody had entered the premises for quite some time. Nobody had a key to the door, and we had to satisfy ourselves with peering at the unit through a small, dust-coated window.

F. Fatiyev, shop senior engineer for oil and gas production, and A. Ashurov, shop process engineer, were unable to find either the gauging and testing log for this unit or its manufacturer's certificate, operating and servicing manual.

"Then how do you determine how much crude each well is producing?" we asked.

"Very simple. We drive a cementing truck carrying a gauging tank up to the well, fill the tank, and calculate its daily production rate. It is, of course, a primitive method," commented F. Fatiyev. If one takes into consideration the fact that the NGDU has practically 60 producing wells, most scattered over marshy ground, practically inaccessible in wet weather, it becomes obvious that one can only very approximately determine the production of each well with the aid of a single cementing unit and a mobile tank.

Disappointment also awaited us at the crude collection station where the Muradkhanly crude is supposed to be demulsified. This facility, which came on-stream three years ago, should already be renovated: the liquid-fuel emulsion-heating ovens proved unserviceable and are presently being replaced by gas-fired units. But only one gas oven is operating at the present time, while the other two, although new, are in a sorry state -- the sheathing is torn and the casings bent. It is therefore not highly

probable that they will go into operation soon, and therefore, as we were told, production only from a few low-flow wells is coming to the crude collection station.

Operations here are interrupted by substantial down-time periods.

"You see, the tank is full," station operator K. Nabiyev told us. "We were unable to pump the crude from it because we had a three-hour power interruption. This frequently occurs here."

As if in confirmation of his statement, the pumps shut down and the lights went out....

In short, there is practically no gauging and testing of the crude produced at Muradkhanly. Just as 3 years ago, it goes right from the high-flow wells directly into the Muradkhanly-Kyurdamir-Ali-Bayramly pipeline. This results in mixing of the production of such wells as No 44, in which water does not exceed 1 percent, and such wells as No 58 where, on the contrary, crude oil comprises only 2 percent. The fact is, an emulsion of approximately 60 percent water content enters the two tanks designated for the Muradkhanlyneft' NGDU at the Ali-Bayramly comprehnsive crude oil treatment section.

"Other problems begin here," we were told by F. Isayev, comprehensive crude oil treatment and transfer shop chief. "Emulsion should stand at least 4 hours in the tank. In actual fact standing time is reduced due to inadequate tankage, as a result of which crude is drained off together with water. This results in a loss of 50 to 60 tons a day, plus an equal amount additionally due to inaccuracy of gauging devices in the tanks."

We could well understand the indignation on this score shown by F. Isayev and all other NGDU personnel with whom we spoke.

It is true, as we were told, that most of the crude lost in this manner is later collected in traps, but it is impossible to establish precisely the quantity involved, for crude from the Shirvanskiye fields also enters these traps.

There is another aspect to this problem. If it were possible to set up in a proper manner gauging and testing of the produced crude and to reduce losses, not only the producers would gain. High-grade crude from the Kyurovdag and Mishovdag fields mixes with the Muradkhanly crude, which possesses other qualitative characteristics, and this leads to failure to meet crude specifications for the refinery equipment, resulting in increased losses at this stage as well.

Nor can one discount the fact that the occurrence of "legitimate" losses with which the NGDU and Azneft' Association management do not properly concern themselves cannot promote greater enthusiasm among the work force for the campaign for thrift and economy, as well as effectiveness of socialist competition.

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August 21 1980